AIR NATIONAL GUARD

Minnesota Air National Guard Base
148th Fighter Wing
Duluth International Airport
Duluth, Minnesota

Installation Restoration Program
Final Feasibility Study Addendum

November 1995

MONTGOMERY WATSON

For the Air National Guard Readiness Center
Under Contract DAHA 90-94-D0013

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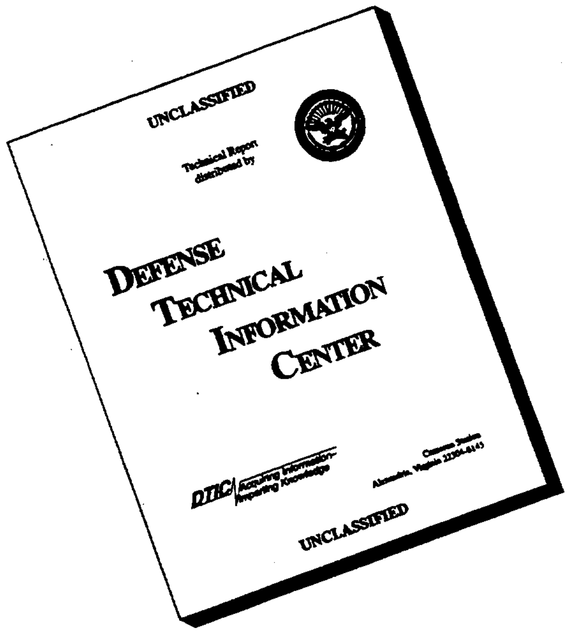

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INSTALLATION RESTORATION PROGRAM

FINAL FEASIBILITY STUDY ADDENDUM

NOVEMBER 1995

MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH INTERNATIONAL AIRPORT
DULUTH, MINNESOTA

Prepared for:

Air National Guard
3500 Fetchet Avenue
Andrews Air Force Base, MD 20331-5157

Prepared by:

Montgomery Watson
545 Indian Mound
Wayzata, MN 55391

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LIST OF ACRONYMS

148FW	148th Fighter Wing
AFFF	Aqueous film-forming-foam
ANG	Air National Guard
ANGRC	Air National Guard Readiness Center
ARAR	Applicable and relevant or appropriate requirements
BEQL	Below estimated quantitation limit
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, xylene
CC	Construction costs
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chemical of concern
DCE	Dichloroethene
DOD	Department of Defense
DPDO	Defense Property Disposal Office
DRMO	Defense Reutilization and Marketing Office
DRO	Deisel range organics
ES	Engineering-Science, Inc.
FAA	Federal Aviation Administration
FS	Feasibility study
FTA	Fire training area
gpd/ft	Gallons per day per foot
GAC	Granular activated carbon
GRA	General response action
GW	Groundwater
HRL	Health risk limits
IRP	Installation restoration program
LOS	Line of site
MANG	Minnesota Air National Guard
MCL	Maximum contaminant level
MDH	Minnesota Department of Health
MEK	Methyl ethyl ketone
MERD	Metal enhanced reductive dehalogenation
µg/kg	Micrograms per kilogram
µg/l	Micrograms per liter
mg/kg	Milligrams per kilogram
mg/l	Milligrams per liter
MPCA	Minnesota Pollution Control Agency
MTBE	Methyltertiarybutylether
NA	Not applicable
NAv	Not available
ND	Not detected
NE	Not established

LIST OF ACRONYMS
(Continued)

NPDES	National pollutant discharge elimination system
PCE	Tetrochloroethene
POTW	Publicly owned treatment works
ppb	Parts per billion
PVC	Polyvinyl chloride
RAO	Remedial action objective
RFRA	Request for response action
RI	Remedial investigation
spd/ft	Gallons per day per foot
SVOC	Semi volatile organic compound
TCA	Trichlorethane
TPH	Total petroleum hydrocarbons
USAF	United States Air Force
USEPA	U.S. Environmental Protection Agency
UVB	Unterdruck-Verdampfer-Brunnen (vacuum vaporizer wells)
VOC	Volatile organic compound

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EXECUTIVE SUMMARY

The Department of Defense (DOD) initiated the Installation Restoration Program (IRP) to identify, report, and correct environmental impacts that could be attributed to past practices on DOD property. The goal of the IRP is to control the migration of hazardous contaminants and to protect public health and the environment from potential threats associated with environmental impacts.

The purpose of this Feasibility Study (FS) Addendum is to address Minnesota Pollution Control Agency (MPCA) comments regarding the previous FS completed by Engineering-Sciences, Inc. (ES 1992), re-evaluate viable alternatives from the existing FS, and develop, screen and evaluate two additional alternatives for both soils and groundwater at the three sites. This FS Addendum is prepared in accordance with guidance published by the United States Environmental Protection Agency (USEPA), "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final" and the Request For Response Action (RFRA) as prepared by the MPCA.

This document evaluates remedial alternatives for soils at Site 3 - Defense Property Disposal Office (DPDO) Storage Area C, now referred to as the Defense Reutilization and Marketing Office (DRMO) (Site 3), and soils at Site 4 - Defense Fuels Tank Farm Area (Site 4). Remedial alternatives for groundwater are evaluated for Site 2 - Fire Training Area (Site 2) and for Sites 3 and 4. This FS Addendum incorporates information and alternatives from the previous FS which are deemed viable considering current environmental conditions and available technologies.

The following provides a brief description of each site addressed by this FS Addendum.

Site 2

Site 2 consists of two former fire training areas (FTA-1 and FTA-2) which are located in the area between existing Taxiway C and the main Runway 9-27 at the Duluth International Airport (Airport). These fire training areas were in use from the early 1950s to as late as 1988 when FTA-2 was reportedly used for the last time. The FTAs were each approximately 40 feet wide by 50 feet long and 4 feet deep (ES 1992).

Previous investigative activities performed at the site have determined that soil contamination is not present at FTA-1. The alternatives developed during the FS recommended a "No-Action" alternative for FTA-1 which was approved by the MPCA. The previous investigative activities have identified impacted soils at FTA-2. The compounds detected in soil at FTA-2 include volatile organic compounds (VOCs). As part of an interim response action, 6,067 cubic yards of soil were excavated and are currently stockpiled at the airport. The management of the remediation of these soils is the responsibility of the Airport and therefore these soils are not addressed in this FS Addendum.

VOC impacts were also detected in groundwater at the site during the remedial investigation. Several VOCs were detected at concentrations which exceeded maximum contaminant levels (MCLs) and Health Risk Limits (HRLs). Recent sampling of the existing monitoring wells at the site indicate that VOC concentrations have decreased to levels below MCLs and HRLs with one exception. Cis-1,2-dichloroethene (cis-1,2-DCE) was detected in one of the monitoring wells at a concentration which exceeds MCLs and HRLs. Since this compound was detected in only one well at elevated levels, it is not considered a serious environmental problem at the site.

Site 3

Site 3 covers approximately five acres and is located south of the western end of the east-west taxiway and lies west of the access road near the western end of Washington Street. Some regrading of the site has occurred to provide level storage areas and drainage ditches to aid in stormwater drainage (ES 1990).

There is contamination of both soil and groundwater at Site 3. Currently the vertical and lateral extent of soil contamination is not clearly defined, however, it is believed that the majority of site contaminants are located within a small storage area formerly called the Defense Property Disposal Office (DPDO) Storage Area C. Soils within the storage area are contaminated by VOCs, Total Petroleum Hydrocarbons (TPH), and pesticides. The volume of contaminated soil has been conservatively estimated at approximately 4,000 cubic yards.

Groundwater beneath the site is impacted by VOCs and semi-volatile organic compounds (SVOCs). Based on the existing data, a plume of VOC contamination emanates from beneath the storage area and extends to the northeast following the local groundwater flow direction (ES 1990). Recent sampling has confirmed that VOCs are still present in site groundwater at concentrations which exceed MCLs and HRLs.

Site 4

Site 4 consists of approximately 15 acres located east of Site 3 and north of Washington Street (ES 1992). The site is occupied by three aboveground storage tanks with a total capacity of approximately 1,000,000 gallons. Two of the tanks are used for the storage of JP-4 fuel. The third tank contained fuel oil No. 2, however due to the possibility of a release from this tank, it was taken out of service in 1982. The exact location of the suspected leak has not been determined. The tanks are surrounded by a dike which has the capacity to contain 110% of the tankage (ES 1992).

Results of the RI do not indicate significant contamination of site soils. Sediment samples collected at the site indicated the presence of fuel oil constituents, benzene, toluene, ethylbenzene, xylene (BTEX), and lead. Significant levels of these compounds are located in the drainage ditch located to the north of the storage tanks. In addition to the sediments in the north drainage ditch, several "hot spots" are located within Site 4 which will require remediation. Therefore, the volume of soil and sediment impacted by fuel oil and BTEX constituents is approximately 227 cubic yards.

In April 1995, six soil samples were collected from within the bermed area surrounding the aboveground fuel storage tanks to confirm conditions within the berms. Two soil samples were collected in the vicinity of each of the three aboveground storage tank. These samples were analyzed for VOCs by MDH 465D and diesel range organics (DRO) by the Wisconsin DRO Method. Detectable concentrations of VOCs are present in two of the soil samples. These samples were collected in the vicinity of the abandoned fuel oil storage tank. The results for DRO indicate that concentrations of DRO are prevalent throughout the berms at the site.

The horizontal and vertical extent of impacted soils has not been determined to date. However, in order for an upcoming project involving the upgrading of fuel tank containment diking to proceed, it is assumed that the top 12 inches of soils within the berms would require excavation and treatment. In addition, the soils which were used for the construction of the berms would be removed and treated. This will result in an additional 4,354 cubic yards of soil from Site 4 to be excavated and treated. The total cubic yards of soil and sediment to be treated at Site 4 is approximately 4,450 cubic yards.

Groundwater impacts from VOCs and total petroleum hydrocarbons (TPH) have been detected in monitoring wells installed at the site. However, these impacts are considered low level based on the existing data (ES 1992).

Report Organization

This FS Addendum consists of the following sections:

- Section 1 contains background information from the previous investigative activities. The background information includes a brief site description and history, and a summary of the nature and extent of contamination. In addition, the analytical results from recent sampling events are presented in this section.
- Section 2 provides responses to MPCA comments from the Feasibility Study prepared by Engineering-Sciences. These comment responses were formulated and provided by the Air National Guard (ANG) formerly known as the Air National Guard Readiness Center (ANGRC).
- Section 3 contains an identification and screening of technologies. In this section remedial action objectives (RAOs) and general response actions (GRAs) were identified based on the existing FS. Potential remedial technologies are identified and a preliminary screening on the basis of their effectiveness, implementability, and cost is performed.
- Section 4 contains a development and screening of alternatives. Technologies retained through the initial screening process were assembled into remediation options. Alternatives range from those that contain provisions for treatment to remedies that provide little or no treatment.

- Section 5 provides a detailed analysis of those alternatives which passed the screening process of Section 4. The criteria used for screening alternatives in this section evaluate the remedy for meeting statutory requirements and the intentions of CERCLA in regards to long-term effectiveness.

The alternatives analyzed in this section are:

Site 2 Groundwater

Alternative	**Action**
GW(1)	No Action

Site 3 Groundwater

Alternative	**Action**
GW(1)	No Action
GW(2)	French Drain
GW(3)	Metal Enhanced Reductive Dechlorination (MERD)

Site 4 Groundwater

Alternative	**Action**
GW(1)	No Action

Site 3 Soil

Alternative	**Action**
S(1)	Institutional Controls
S(3)	Incineration
S(4)	Aboveground Bioremediation

Site 4 Soil

Alternative	Action
S(1)	Institutional Controls
S(3)	Incineration
S(4)	Aboveground Bioremediation

- Section 6 presents the preferred alternative for each site based on the detailed analysis and comparison of the nine criteria as presented in the CERCLA guidance. The following preferred alternatives were selected:

The preferred alternative for Site 2 groundwater is groundwater monitoring. Recent groundwater sampling has indicated that the chlorinated compounds previously detected in site groundwater have been reduced to concentrations less than MCLs or HRLs with the following exception. Cis-1,2-DCE which was not previously analyzed for at the site was detected at a concentration of 230 µg/l in the February 2, 1995 sampling event. This concentration does exceed MCLs and HRLs. However, this does not represent a wide spread problem since cis-1,2-DCE was only detected in a single well at the site. The groundwater monitoring plan would include collecting groundwater samples from the existing monitoring well network on a quarterly basis for a period of two years.

The preferred alternative for Site 3 groundwater is Alternative GW(2) - French Drain. Alternative GW(2) is a viable alternative for protecting human health and the environment. This remedy would utilize a french drain to collect groundwater, treat groundwater using granular activated carbon, and discharge of treated water to a publicly owned treatment works (POTW).

The preferred alternative for Site 3 soils is Alternative S(4) - Aboveground Bioremediation. This alternative provides protection to human health and the environment. This alternative consists of excavating impacted soils and sediments and transporting them to an aboveground treatment cell which will be constructed within the perimeter of the Duluth International

Airport. Degradation of soil contaminants would be enhanced through the introduction of essential nutrients, water and oxygen.

The preferred alternative for Site 4 soil and sediment is Alternative S(4) - Aboveground Bioremediation. This alternative provides protection to human health and the environment. This alternative consists of excavating impacted soils and sediments and transporting them to an aboveground treatment cell which will be constructed within the perimeter of the Duluth International Airport. Degradation of soil contaminants would be enhanced through the introduction of essential nutrients, water and oxygen.

The preferred alternative for Site 4 groundwater is groundwater monitoring. Historic groundwater sampling has indicated that benzene was previously detected in site groundwater at concentrations exceeding MCLs and HRLs. The groundwater monitoring plan would include collecting groundwater samples from the existing monitoring well network on a quarterly basis for a period of two years.

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SECTION 1.0
INTRODUCTION

The Department of Defense (DOD) initiated the Installation Restoration Program (IRP) to identify, report, and correct environmental impacts that could be attributed to past practices on DOD property. The goal of the IRP is to control the migration of hazardous contaminants and to protect public health and the environment from potential threats associated with environmental impacts.

Under contract DAHA90-94-D-0013, Delivery Order No. 0011, the U.S. Air National Guard Readiness Center (now known as the Air National Guard) has retained Montgomery Watson to prepare a Feasibility Study (FS) Addendum for Sites 2, 3, and 4 at the Minnesota Air National Guard 148th Fighter Wing (148 FW) at Duluth, Minnesota. Specific FS activities at the 148th FW are being conducted in accordance with a Request For Response Action (RFRA) between the State of Minnesota and the U.S. Air Force (USAF), the Air National Guard Readiness Center (ANGRC), and the Minnesota Air National Guard (MANG). The RFRA established procedures and schedules for investigating and remediating Sites 2, 3, and 4.

1.1 PURPOSE

This FS Addendum is intended to address Minnesota Pollution Control Agency (MPCA) comments regarding the previous FS completed by Engineering-Sciences, Inc. (ES 1992), re-evaluate viable alternatives from the existing FS, and develop, screen and evaluate two additional alternatives for both soils and groundwater at the three sites. This FS Addendum is not intended to be a stand alone document but to supplement the existing FS, therefore the reader is referred to the Remedial Investigation (RI) and Feasibility Study reports previously prepared by ES for more detailed information regarding past investigative activities at the sites.

This document evaluates remedial alternatives for soils at Site 3 - Defense Property Disposal Office (DPDO) Storage Area C, now referred to as the Defense Reutilization and Marketing Office (DRMO) (Site 3), and soils at Site 4 - Defense Fuels Tank Farm Area (Site 4). Remedial alternatives for groundwater are evaluated for Site 2 - Fire Training Area (Site 2) and for Sites 3

and 4. This FS Addendum incorporates information and alternatives from the previous FS which are deemed viable considering current environmental conditions and available technologies.

1.2 FS ADDENDUM ORGANIZATION

This FS Addendum was prepared in accordance with guidance published by the United States Environmental Protection Agency (USEPA) titled "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA - Interim Final. October 1988."

In addition to this Introduction, this report is comprised of five other sections. These sections are summarized as follows:

- Section 2 - Responses to MPCA comments regarding the FS previously prepared by ES.

- Section 3 - Identification of technologies with the potential to remediate site soils and groundwater. This section includes a summary of technologies previously evaluated by ES and two additional technologies each for soil and groundwater.

- Section 4 - Development and screening of remediation alternatives based on effectiveness, implementability, and cost for the selected technologies for site soils and groundwater. Alternatives include viable alternatives from the ES FS and new alternatives agreed to in a 14 February 1995 meeting with personnel from the MPCA, the Air National Guard, and Montgomery Watson.

- Section 5 - This section presents a detailed analysis of the alternatives developed in Section 4. These alternatives are evaluated based on the nine screening criteria as presented in the CERCLA guidance document. Following this screening the alternatives are compared against each other to determine the preferred alternative.

- Section 6 - The final section of the FS Addendum presents the preferred alternatives for remediation of site soil and groundwater.

1.3 BACKGROUND INFORMATION

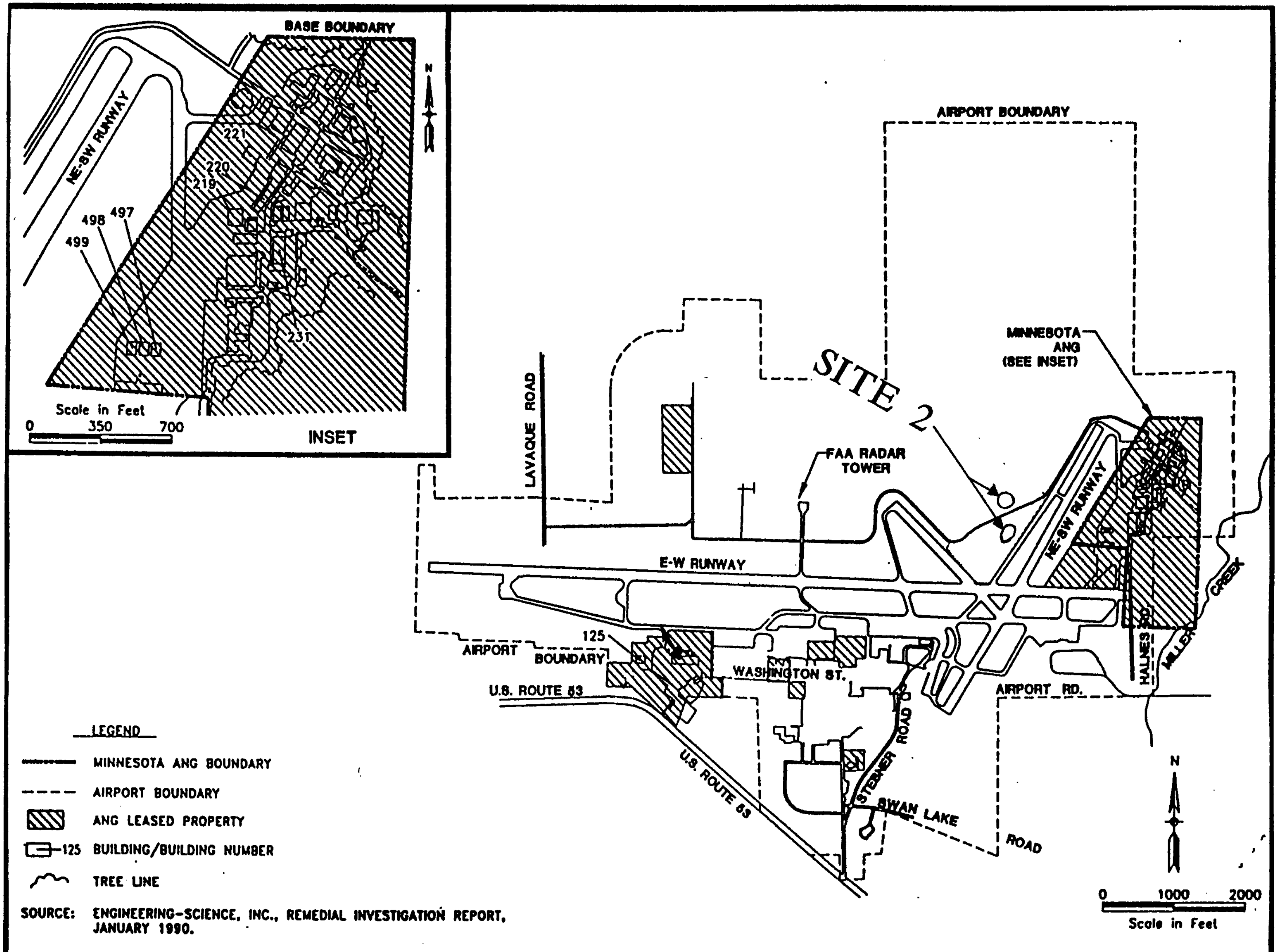
This section presents specific background information for Sites 2, 3, and 4 at the 148th FW in Duluth, Minnesota. This section provides details as to the site description, history, and nature and extent of contamination for each site.

1.3.1 Site 2

1.3.1.1 Site Description. Site 2 consists of two former fire training areas (FTA-1 and FTA-2) which are located in the area between existing Taxiway C and the main Runway 9-27 at the Duluth International Airport (Airport). Figure 1-1 presents the location of Site 2. The site covers approximately 50 acres of grassy and lightly wooded areas. These fire training areas were in use from the early 1950s to as late as 1988 when FTA -2 was reportedly used for the last time. The FTAs were each approximately 40 feet wide by 50 feet long and 4 feet deep (ES 1992).

Based on the results of previous investigative activities at the site (remedial investigation, January 1990), it was determined that soil contamination was not present at FTA-1. The alternatives developed during the FS recommended a "No-Action" alternative for FTA-1. Upon review of the RFRA requirements by the MPCA, MPCA staff has approved that "No-Further-Action" is required for FTA-1 (MPCA 1991). Therefore, the FTA-1 portion of Site 2 will not be considered during the alternatives development of this FS Addendum. A copy of the MPCA approval letter for FTA-1 is included in Appendix A.

1.3.1.2 Site History. Materials burned in the FTAs included JP-4 fuel and drummed materials consisting of waste oils, thinners, and solvents brought from the DRMO. The fires were extinguished using a protein-based aqueous film-forming foam (AFFF) or chlorobromomethane. It is possible that carbon tetrachloride was also used as an extinguishing agent during the early years of pit operation (ES 1992).



MONTGOMERY WATSON *Wayzata, Minnesota*	MINNESOTA AIR NATIONAL GUARD DULUTH, MINNESOTA LOCATION OF SITE 2	FIGURE **1-1**

1.3.1.3 Nature and Extent of Contamination. Due to past practices at the site, soils have been impacted by various chlorinated volatile organic compounds (VOCs), benzene, toluene, ethylbenzene, and xylene (BTEX) to depths as great as 12 feet below ground surface (bgs). The most prevalent VOCs detected at the site include tetrachloroethene, 1,2-dichlorobenzene, trichloroethene, and trans-1,2-dichloroethene. The volume of soil impacted at the site has previously been estimated to be 6,067 cubic yards. As part of an interim response action, these soils were excavated and are currently stockpiled at the airport. Under an agreement between the Duluth Airport Authority (Airport Authority) and the 148TH FW, the remediation of these soils is being managed by the Airport Authority and, therefore, are not considered in this FS Addendum. The 148TH FW retains overall responsibility for the soils. Recent sampling of the stockpiled soils indicate that the chlorinated compounds are no longer at detectable levels.

Groundwater samples collected as part of the RI indicated the presence of VOCs in monitoring wells (MW-1, MW-2, GW-2E and DANGB-2-MW38) at both FTA-1 and FTA-2. At the time of the groundwater sampling event (July 25, 1988 to September 23, 1988), trans-1,2-dichloroethene, trichloroethene, and vinyl chloride were detected above their respective maximum contaminant level (MCL). Contamination at the site has been documented as separate groundwater contaminant plumes emanating from beneath FTA-1 and FTA-2. These plumes are oriented to the northeast and follow the general groundwater flow direction in the vicinity of Site 2.

There are no significant chemical impacts to sediments at the site. One sediment sample was found to contain low levels (0.26 parts per billion (ppb)) of trichloroethene. The reader is referred to Tables 3-1 through 3-4 of the previous FS (ES 1992) for a summary of the contaminants detected at the site. Tables 3-1 through 3-4 are included in Appendix B of this report.

In February 1995 one round of groundwater samples was collected from the monitoring wells at Site 2 (MW-1, MW-4, GW-2C, GW-2D, GW-2E). These samples were analyzed for VOCs, semi-volatile organic compounds (SVOCs), and gross alpha and gross beta. A summary of the analytical results is presented in Table 1-1 of this FS Addendum. As presented in Table 1-1, contaminant levels for previously detected compounds have decreased with the noted exceptions. Benzene concentrations have increased from 1.2 to 2.1 micrograms per liter (μg/l) since the RI

sampling event. Cis-1,2-dichloroethene, which was previously not analyzed for, was detected in one of the monitoring wells at 230 µg/l.

TABLE 1-1

SITE 2
SUMMARY OF FEBRUARY 1995 GROUNDWATER ANALYTICAL RESULTS
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Method	Constituent	Date	MW-1	MW-4	GW-2C	GW-2D	GW-2E
SVOCs (EPA 8270)		2/1/95	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
VOCs (MN 465E)	Acetone	2/2/95	BDL	BDL	BDL	1.4	BDL
	Methylene chloride		6.2	5.1	6.0	BDL	BDL
	MTBE		2.0	2.1	1.3	BDL	BDL
	trans-1,2-Dichloroethene		BDL	BDL	BDL	BDL	18.0
	MEK		BDL	BDL	BDL	BDL	2.6
	cis-1,2-Dichloroethene		3.3	BDL	BDL	3.6	230.0
	Tetrahydrofuran		3.7	BDL	3.6	BDL	BDL
	Benzene		BDL	BDL	BDL	2.1	2.1
	Trichloroethene		BDL	BDL	BDL	BDL	2.1
	Napthalene		1.3	1.3	BDL	1.4	1.5
	Vinyl Chloride		BDL	BDL	BDL	BDL	BDL
Gross Alpha/Gross Beta (EPA 9310)		2/1/95	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]

Notes 1: All constituents for EPA Methods 8270 and 9310 were non-detect. All samples collected by Twin Ports Testing (February 1995).

BDL = Below Detection Limits

All concentrations in µg/l

1.3.2 Site 3

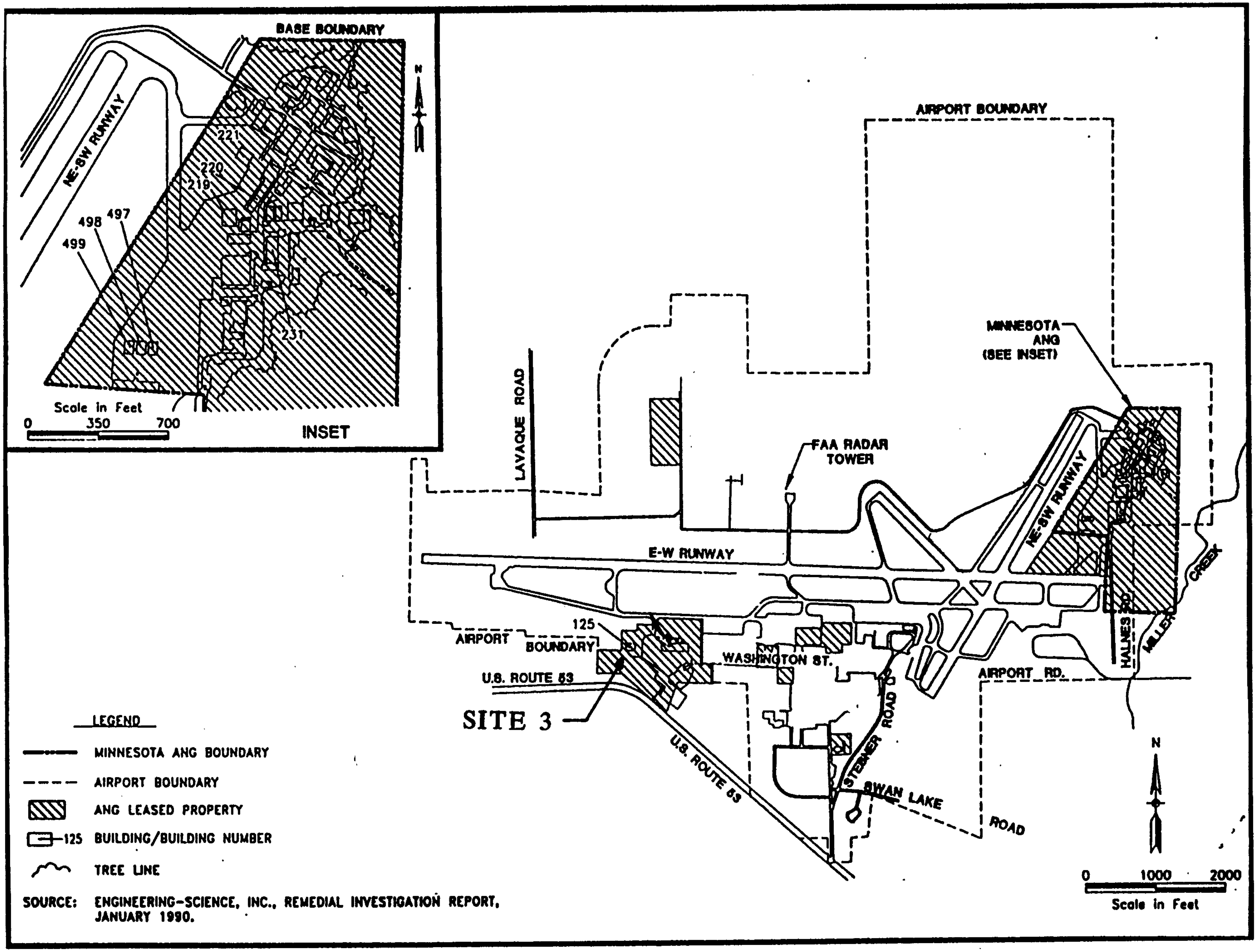
1.3.2.1 Site Description. Site 3 covers approximately five acres and is located south of the western end of the east-west taxiway and lies west of the access road near the western end of Washington Street. Figure 1-2 presents the location and layout of Site 3. The site consists of paved storage areas, woodland, grassy areas, and roadways. Some regrading of the site has occurred to provide level storage areas and drainage ditches to aid in stormwater drainage (ES 1990).

The site is currently occupied by four buildings and level storage areas as part of the DRMO. Approximately eight employees work at the DRMO facility. However, other workers and the public visit the facility to drop off or pick up excess equipment and supplies (ES 1990).

The contamination source area is a small storage area formerly called the DPDO Storage Area C. This storage area is approximately 90 feet long and 120 feet wide and consists of a flat surface covered with pea gravel. A drainage ditch borders Storage Area C to the east and north (ES 1992).

1.3.2.2 Site History. From 1965 to 1980, waste petroleum, oils and lubricants, waste solvents, and chemicals were stored on a storage area located to the southwest of the DRMO building. The maximum number of containers stored at any time was 100 55-gallon drums. This site was the location of minor drum leaks in the past. No major spills have been recorded at the site. The storage area is no longer used for the temporary storage of drums (ES 1992).

1.3.2.3 Nature and Extent of Contamination. There is contamination of both soil and groundwater at Site 3. Currently the vertical and lateral extent of soil contamination is not clearly defined, however, it is believed that the majority of site contaminants are located within Storage Area C. Soils within the storage area are contaminated by VOCs, total petroleum hydrocarbons (TPH), and pesticides. The dimensions of Storage Area C are approximately 90 feet by 120 feet. Depth to groundwater at the site is approximately 10 feet. Since groundwater at the site is impacted by VOCs, it is probable that the entire unsaturated soil column is impacted. The volume of contaminated soil has been conservatively estimated at approximately 4,000 cubic yards.



MONTGOMERY WATSON
Wayzata, Minnesota

MINNESOTA AIR NATIONAL GUARD
DULUTH, MINNESOTA
LOCATION OF SITE 3

FIGURE
1-2

One sediment sample, outside the storage pad area, was found to contain elevated concentrations of VOC and SVOCs. This sample is located downslope from Storage Area C. The FS estimated that the area of sediment contamination is approximately 2 feet wide by 18 feet long. The estimated depth of sediment contamination is approximately one foot (ES 1992). These dimensions represent a contaminated volume of approximately 1.3 cubic yards.

Groundwater beneath the site is impacted by VOCs and SVOCs. The significant contaminants include 1,1-dichloroethane, trans-1,2-dichloroethene, 1,1,1-trichloroethene, tetrachloroethene, trichloroethene, and vinyl chloride which were all detected above MCLs during the RI (ES 1990). Samples were collected between July 25, 1988 and September 23, 1988. Based on the existing data, a plume of VOC contamination emanates from beneath the storage pad and extends to the northeast following the local groundwater flow direction. The reader is referred to Appendix B of this report for summary tables, from the FS (ES 1992), of the contaminants detected at the site.

In April 1995, one round of groundwater samples was collected from seven of the monitoring wells at Site 3. The seven wells sampled were those wells which have historically exhibited the highest concentrations of VOCs and SVOCs. Groundwater samples were analyzed for VOCs by Minnesota Department of Health (MDH) Method 465D, SVOCs by EPA Method 8270, and diesel range organics (DRO) by the Wisconsin DRO Method. The results of the sampling event are summarized in Table 1-2. As indicated in Table 1-2, detectable concentrations of 1,1-dichloroethene, trans-1,2-dichloroethene, 1,1-dichloroethane, cis-1,2-dichloroethene, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, vinyl chloride and DRO were encountered in five of the monitoring wells sampled.

1.3.3 Site 4

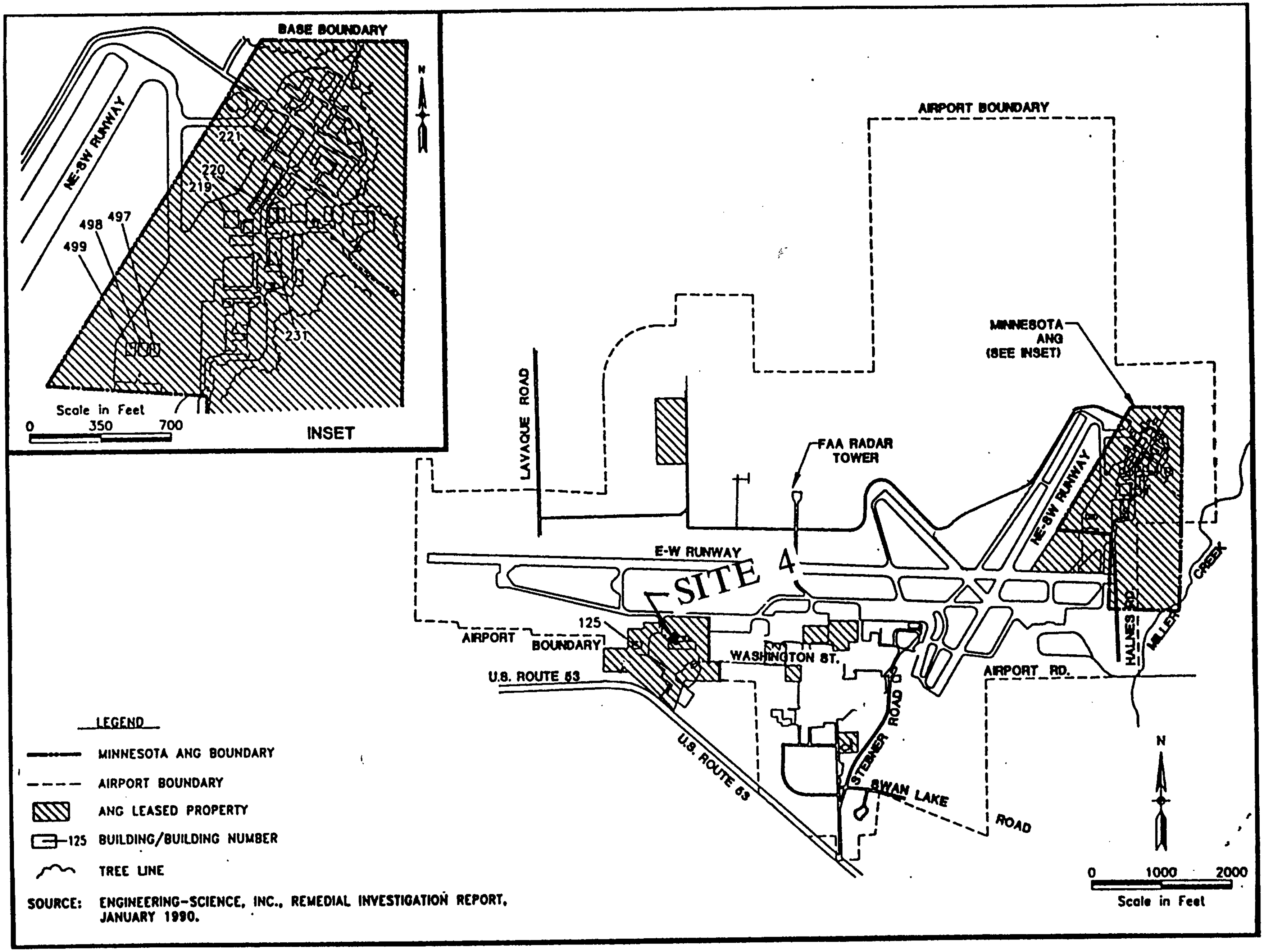
1.3.3.1 Site Description. Site 4 consists of approximately 15 acres located east of Site 3 and north of Washington Street. The location of Site 4 is presented in Figure 1-3. The site is comprised of grassy areas, roadways, and some marshy areas (ES 1992). The site is occupied by three aboveground storage tanks with a total capacity of approximately 1,000,000 gallons. In addition to the tanks, ancillary equipment and loading and unloading facilities are also present at the site. Two of the tanks are used for the storage of JP-4 fuel. The third tank contained fuel oil

TABLE 1-2

SITE 3
SUMMARY OF APRIL 1995 GROUNDWATER ANALYTICAL RESULTS
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Method	Date	Constituent	GW-3A	GW-3C	GW-3D	DANGB-3 MW25	DANGB-3 MW27	DANGB-3 MW29	DANGB-3 MW35
VOCs (µg/l) (MDH 465D)	6/4/95	Dichlorofluoromethane	ND	ND	ND	ND	ND	BEQL	ND
		Acetone	ND	BEQL	ND	ND	ND	BEQL	ND
		1,1-Dichloroethene	ND	ND	BEQL	BEQL	ND	ND	10
		trans-1,2-Dichloroethene	ND	ND	ND	BEQL	ND	ND	39
		1,1-Dichloroethane	ND	ND	BEQL	BEQL	ND	ND	39
		Methyl ethyl ketone	ND	ND	BEQL	ND	ND	ND	ND
		cis-1,2-Dichloroethene	ND	ND	ND	20	ND	BEQL	ND
		1,1,1-Trichloroethane	ND	ND	390	ND	ND	1.2	ND
		Trichloroethene	ND	ND	ND	130	ND	3.1	ND
		Tetrachloroethene	ND	280	770	ND	ND	1.6	ND
		Vinyl Chloride	ND	ND	ND	30	ND	ND	ND
Diesel Range Organics (mg/l) (Wisconsin DRO Method)	6/4/95	DRO	BPQL	0.2	0.5	BPQL	BPQL	BPQL	1.3
SVOCs (µg/l) (EPA 8270)	6/4/95	Napthalene	ND	ND	BEQL	ND	ND	ND	ND

Notes: ND = Not detected
BEQL = Detected but at a concentration Below the Estimated Quantitation Limit.
BPQL = Not detected at a level above the practical quantitation limit.



MONTGOMERY WATSON
Wayzata, Minnesota

MINNESOTA AIR NATIONAL GUARD
DULUTH, MINNESOTA
LOCATION OF SITE 4

FIGURE
1-3

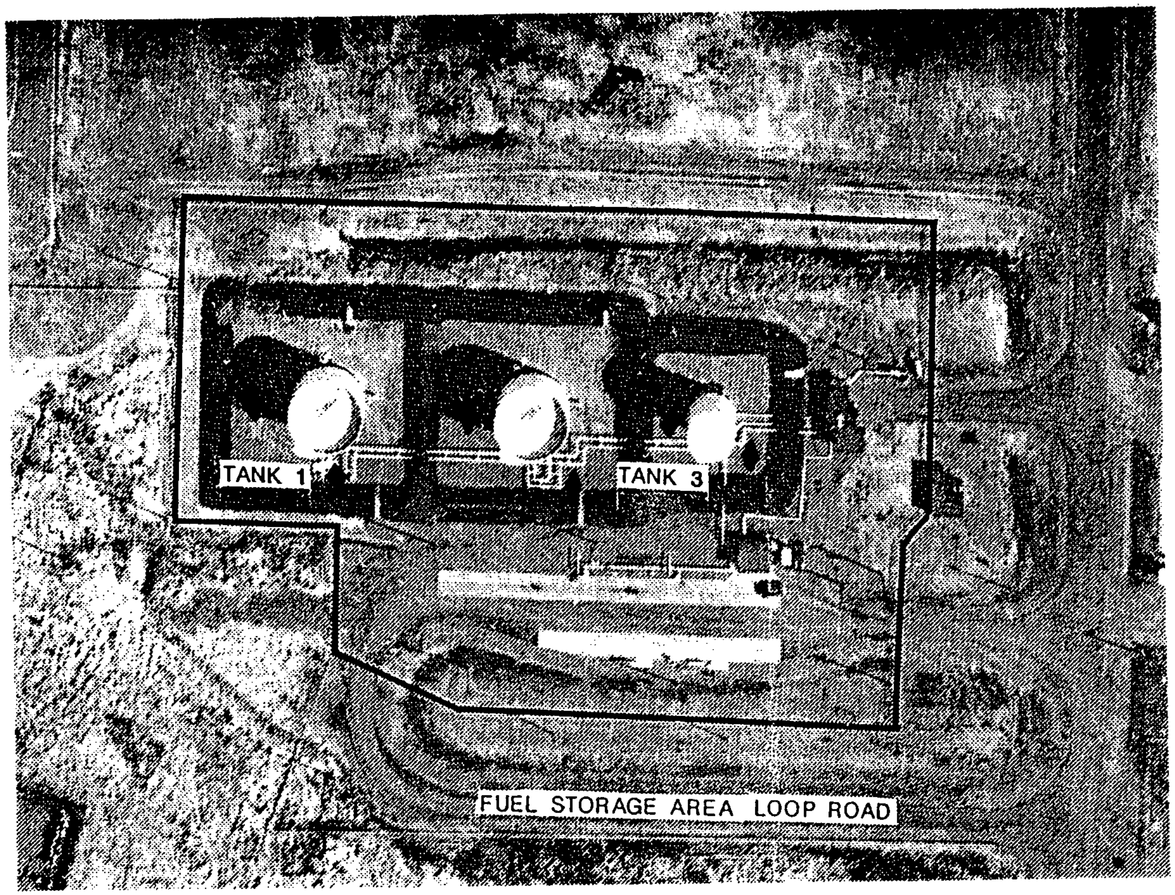
No. 2, however due to the possibility of a release from this tank, it was taken out of service in 1982. The exact location of the suspected leak has not been determined. The tanks are surrounded by a dike which has the capacity to contain 110% of the tankage (ES 1992).

1.3.3.2 Site History. The tanks were constructed in the 1950s. In 1980 a leak was discovered approximately 150 feet away from Tank No. 3. Fuel oil No. 2 was observed at a depth of 6-7 feet bgs during the repair of a waterline. The leak was located approximately 100 feet outside the bermed area for the tanks (ES 1990).

1.3.3.3 Nature and Extent of Contamination. Results of the RI indicate contamination of sediments in drainage ditches at this site. Sediment samples collected at the site indicated the presence of fuel oil constituents, BTEX, and lead. Significant levels of these compounds are located in the drainage ditch located to the north of the storage tanks. Based on the existing data from the site, it is assumed that the entire length of the north drainage ditch is impacted. Therefore, the estimated volume of sediment requiring remediation at the site is define by an area 500 feet long, 5 feet wide, and 1 foot deep or 93 cubic yards (ES 1992). It should be noted that the areal extent of contamination within the drainage ditch has not been determined since clean sediment samples have not been recovered. In addition to the sediments in the north drainage ditch, several "Hot Spots" are located within Site 4. These include the western end of the south drainage ditch and areas near sampling points DANGB-4-MW23, DANGB-4-MW22, and DANGB-4-SL14. Therefore, the volume of soil and sediment impacted by fuel oil and BTEX constituents is approximately 227 cubic yards.

In addition, soils in the area surrounding the fuel storage tanks may be impacted. Contamination was noted during the collection of a soil sample for geotechnical testing.

In April 1995, six soil samples were collected from within the bermed area surrounding the aboveground fuel storage tanks. The locations of these soils samples are presented in Figure 1-4. Two soil samples were collected in the vicinity of each of the three aboveground storage tanks. Soil samples were collected from the southern side of the tanks near the existing piping runs and on the west side of each tank. Soil samples could not be collected from the northern portion of the berms due to frozen ground. These samples were analyzed for VOCs by MDH 465D and DRO



Scale 1" = 125'

EXPLANATION

♦ Soil sampling location - April 7, 1995

MONTGOMERY WATSON *Wayzata, Minnesota*	MINNESOTA AIR NATIONAL GUARD DULUTH, MINNESOTA SITE 4 SOIL SAMPLING LOCATIONS	FIGURE **1-4**

by the Wisconsin DRO Method. The analytical results from this sampling event are summarized in Table 1-3. As presented in the table, detectable concentrations of VOCs are present in two of the soil samples. These samples were collected in the vicinity of the abandoned fuel oil storage tank. The results for DRO indicate that concentrations of DRO are prevalent throughout the berms at the site.

The horizontal and vertical extent of impacted soils has not been determined to date. However, in order for an upcoming project involving the upgrading of fuel tank containment diking to proceed, it is assumed that the top 12 inches of soils within the berms would require excavation and treatment. In addition, the soils which were used for the construction of the berms would be removed and treated. This will result in an additional 4,354 cubic yards of soil from Site 4 to be excavated and treated. The total cubic yards of soil and sediment to be treated at Site 4 is approximately 4,600 cubic yards.

Groundwater impacts from VOCs and TPH have been detected in monitoring wells installed at the site and sampled between July 25, 1988 and September 23, 1988 as part of the RI (ES 1990). However, these impacts are considered as low level based on the existing data (ES 1992). In addition to the low concentrations, the existing FS has assumed that groundwater discharges to the drainage ditches. Off-site migration of these constituents is assumed to be through surface water transport. Therefore, groundwater contamination is assumed to be limited to the area between the southern and northern drainage ditches. Analytical results for samples collected at Site 4 are presented in the existing FS (ES 1992). Copies of summary tables from the FS have been included in Appendix B of this report.

TABLE 1-3

SITE 4
SUMMARY OF APRIL 1995 SOIL ANALYTICAL RESULTS
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Method	Date	Constituent	POL-SS-1	POL-SS-2	POL-SS-3	POL-SS-4	POL-SS-5	POL-SS-6
VOCs (µg/Kg) (MDH 465D)	6/4/95	Vinyl Chloride	ND	ND	ND	ND	ND	BEQL
		Acetone	BEQL	BEQL	ND	BEQL	BEQL	660
		Methyl ethyl ketone	ND	BEQL	BEQL	ND	BEQL	ND
		Ethylbenzene	ND	ND	ND	ND	ND	BEQL
		m,p-Xylene	ND	ND	ND	ND	ND	BEQL
		Isopropylbenzene	ND	ND	ND	ND	BEQL	BEQL
		n-Propylbenzene	ND	ND	ND	ND	1,800	BEQL
		1,3,5-Trimethylbenzene	ND	ND	ND	ND	11,000	2,000
		2-Chlorotoluene	ND	ND	ND	ND	1,400	BEQL
		4-Chlorotoluene	ND	ND	ND	ND	1,400	BEQL
		1,2,4-Trimethylbenzene	ND	ND	ND	ND	3,200	BEQL
		sec-Butylbenzene	ND	ND	ND	ND	BEQL	ND
		4-Isopropyltoluene	ND	ND	ND	ND	5,400	580
		Naphthalene	ND	ND	ND	ND	BEQL	180
Diesel Range Organics (mg/Kg) (Wisconsin DRO Method)	6/4/95	DRO	14	14	7	BPQL	420 [a]	510 [a]

Notes: ND = Not detected
BEQL = Detected at a concentration less than the Estimated Quantitation Limit but greater than ND.
a: Samples contain hydrocarbon product which elutes before the retention time range provided by the DRO standard.

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SECTION 2.0
RESPONSES TO COMMENTS

This section provides specific responses to the MPCA suggested modifications and comments to the Draft Feasibility Study Report (ES 1992) presented in correspondence to the Air National Guard Readiness Center on 14 October 1992 (see Appendix C of this document).

MPCA Modification #1

Section 1.3, pg. 1-8, first paragraph.
It is stated in this paragraph that "health-based cleanup levels for the contaminated ground water on Base are probably inappropriate." This type of conclusion seems inappropriate in this section of feasibility study objectives, approach and report organization. In addition, the statement is inaccurate in that Minnesota's nondegradation policy for natural waters is ultimately designed to be protective of human and ecological risks.

Also on this page regarding the statement "levels of cleanup for soil based on potential for contaminants to leach to ground water," it is unclear what levels of cleanup are being referred to.

ANGRC Response

As stated throughout this report, the investigations have shown that no significant risk exists to human health. The primary reason for conducting remediation is to prevent the spread of contaminants to potable water or sensitive environments.

The cleanup levels provided by MPCA that have been applied to Site 2 and other sites.

MPCA Modification #2

Section 1.3, pg. 1-8

In the discussion of potential cleanup criteria, no mention was made of the soil cleanup levels set by Minnesota Pollution Control Agency (MPCA) pursuant to the "Procedures For Establishing Soil Cleanup Levels" Version 1. This document shall be cited as another cleanup criterion. The actual cleanup numbers are provided in Attachment 2.

ANGRC Response

The MPCA document will be included in the cleanup criterion in the Feasibility Study Addendum.

MPCA Modification #3

Section 1.3, pg. 1-11

The criteria indicated to be used in evaluating potential technologies referred to reduction of contaminant mobility, toxicity and volume, to the prevention of exposure, to contaminated ground water, and the restoration of contaminated ground water. This FS Report shall also discuss in this regard the other factors identified in Tasks A and B of Part VI to Exhibit A to the Request For Response Action. This modification also applies to the screening of alternatives discussed in Section 4.

ANGRC Response

It is included in the FS Addendum.

MPCA Modification #4

Table 3.1, pg. 3-2

Background levels are reported for numerous constituents as non-detected (ND). In future reports such data presented in tables shall be noted either as their respective magnitude (i.e.,

<0.5 microgram/liter (ug/l)) or the detection limits shall be included in a separate column within the summary table for comparison.

ANGRC Response

Agree

MPCA Modification #5

Table 3.2, Summary of Ground Water Contaminants By Site, pg. 3-4
For Site 2, this table indicates that Perchloroethylene (PCE), Toluene, 111-Trichloroethane (TCA) and Xylenes were not analyzed. It also indicates Xylene was not analyzed at Site 3. Information from the Remedial Investigation indicates, however, that Methods 810 and 8020 were used for these samples and Appendix L has the reported analytical results for these compounds. It appears that the "not analyzed" (NA) should actually be ND's. The table shall be modified to accurately reflect existing data.

ANGRC Response

We will use ND, not NA in future reports.

MPCA Modification #6

Section 3.1.4.1, 3-20
The discussion of total petroleum hydrocarbons at Site 8 is too cursory. Total Petroleum Hydrocarbons (TPH) levels greater than 50 milligram/kilogram (mg/kg) occur at several locations and must be addressed. All levels of TPH greater than 50 mg/kg shall be addressed in the report as significant contamination potentially requiring remediation. If remediation for soils containing levels of TPH at or greater than 50 mg/kg is not recommended, rationale must be presented to support the "no-action" recommendation.

Also, : um detection limit of 100 mg/kg is too high and for future verification sampli :tection levels shall be no higher than 50 mg/kg. A minimum detection limit ev :r than 50 mg/kg is preferred.

ANGRC Respon

Development by the City of Duluth at Site 8 required a decision on this site. The City of Duluth conducted additional testing, which confirmed the recommendation for No Further Action. MPCA approved the no further action decision in August 1993. Based on the approved no further action decision, comments about Site 8 will not be addressed further.

We agree, in future we will use a lower detection limit.

MPCA Modification #7

Section 3.3, pp. 3-39 et seq

The Baseline Risk Assessment was developed strictly for human exposure. No significant discussion occurred for the Ecological Risk, in light of the Minnesota Non-Degradation Goal stated in the 1989 Ground Water Protection Act, Minn. Stat. 103H, and developed in Minnesota Rule 7060.

ANGRC Response

Appendix C contains the Environmental Assessment and Environmental Impacts.

MPCA Modification #8

Section 4, pp. 4-1 et seq

The FS does not provide a Table of Applicable or Relevant and Appropriate (ARARs) factor for soil, sediment surface and ground waters. The ARARs of concern for the various media that apply to the sites shall be presented in tabular form with a corresponding discussion.

ANGRC Response

It is included in the FS Addendum.

MPCA Modification #9

Section 4.2.1.3, pg. 4-18

Alternative 2 consisting of a multilayered cap is considered applicable to Site 2 FTA-2 area and to Site 3. As stated in the cover letter, the "Line-Of-Sight" (LOS) requirements established by the Federal Aviation Administration (FAA) for Site 2 cause this alternative to be inappropriate for Site 2. For Site 3, this alternative could be potentially applicable, but since treatment of contaminants is preferred, the cap would also be found inadequate. Therefore, this alternative shall be rejected for all sites at the DAFB.

ANGRC Response

Agree. A cap will not be considered in the FS Addendum.

MPCA Modification #10

Section 4.2.1.7, pg. 4-22, first paragraph

Low temperature thermal treatment (soil roasting) is described as being effective for volatile organic compounds (VOCs) but not for semi-volatile organic compounds (SVOCs). Low temperature roasters in Minnesota are currently approved only for typical nonhalogenated petroleum VOCs such as Benzene, Ethylbenzene, Toluene and Xylene (BTEX) and TPH contaminated soils. Treatment of soils that contain other contaminants such metals or halogenated VOCs is approved only on a site by site basis by the Air Quality Division of the MPCA. For soil containing low levels of SVOCs and halogenated solvents sufficient data on air quality to allow approval by the Air Quality Division. The report shall be modified to reflect these considerations.

Section 4.2.1.7, pg. 4-22, fourth paragraph

Alternative S7 (excavation and low temperature thermal treatment) is not applicable to Site 2 and would be only limited to treatment of soils from Site 3 that contain only nonhalogenated petroleum related VOCs, TPH or very low (trace) amounts of other solvents. See above comment.

ANGRC Response

The FS Addendum will use present MPCA guidelines and policies for thermal treatment.

Due to construction by NW Airlines the soil at Site 2 was removed, and is being remediated under an agreement between the Air National Guard and the Duluth Airport Authority. The MPCA has approved the removal and remediation of soils at Site 2, along with approved soil cleanup levels. Comments on soils at Site 2 will not be addressed further.

MPCA Modification #11

Section 4.2.2.2, pg. 4-25

The text shall be modified to indicate that ground water shall be sampled at least initially on a quarterly basis.

ANGRC Response

Quarterly sampling will be used in the FS Addendum.

MPCA Modification #12

Section 4.2.2.2 - 4.2.2.5

In these sections, options that utilize an interceptor trench are discussed in the development of alternative sections. Only one section (4.2.2.2) discusses discharge of water to the sanitary sewer, the other options (4.2.2.3-4.2.2.5) discuss the use of an interceptor trench

with discharge to a nearby stream following treatment. It is assumed in this discussion that treatment of the water will not be required prior to discharging to the sanitary sewer. If this assumption is made, the rationale underlying this assumption shall be stated explicitly. If, alternatively, additional treatment prior to discharging to the sanitary sewer is possible or likely at some locations, this alternative shall be discussed.

ANGRC Response

The FS Addendum will address requirements for discharging water, for all options considered.

MPCA Modification #13

Section 4.2.3.1, Alternative SW1, pg. 4-27
In the discussion of the soil washing treatment option, the contaminated water used in the treatment process is allowed to drain onto the site and back into existing contaminated ground water. It may be necessary, however, to treat this waste process water to avoid deterioration of site soils and ground water or discharge to the sanitary sewer or surface stream. This shall be discussed within the report.

ANGRC Response

See response above.

MPCA Modification #14

Section 4.3.1, pg. 4-32
The statement "no sediment contamination exists" in reference to Site 3 at the end of the first paragraph is incorrect. Please refer to cleanup levels presented in Attachment II for a discussion of relevant contaminants of concern.

ANGRC Response-

The cleanup levels in Attachment II to the MPCA October 14, 1992, or most recent cleanup levels will be used in the FS Addendum. Attachment II is included as Appendix C of this report.

MPCA Modification #15

Section 4.3.1, pg. 4-33
No mention is made of the locally high levels of TPH at Site 8 which range from 160 to 3300 mg/kg from surface soil and sediment locations. This contamination shall be addressed within the report.

In Table 4.4, no contamination is indicated for Site 8 with the note that either all analytes were below the cleanup range or below the detection limit. The enclosed cleanup levels for the individual sites will allow Engineering Science to determine if levels are above or below cleanup requirements. Levels of TPH are locally higher than the 10 to 50 parts per million range typically used for cleanup requirements on many similar tank and tank farm sites in Minnesota. After reviewing the enclosed cleanup levels any and all contamination at or above these goals shall be acknowledged. If some locations are concluded not to require remediation, supporting rationale shall be presented in all cases.

ANGRC Response

See response to modifications #6.

MPCA Modification #16

Table 4.3, pg. 4-16
Due to considerations for treating soil at Site 8 with TPH levels 50 mg/kg or higher, Site 8 shall be added for consideration to Alternative S3 and S7. All discussion and conclusions regarding the remediation of these soils shall include a rationale for its selection.

Also regarding Alternative S2, since a cap cannot be considered at Site 2, acknowledgment must be made of the FAA LOS requirements for Site 2. The text shall be changed to reflect the excavation required by the FAA as part of the LOS requirements.

Again the LOS requirements should be discussed in Section 4.3.2.2, pg. 4-40 with regard to the option of a cap at Site 2.

ANGRC Response

See response to modification #6 and #10.

MPCA Modification #17

Section 4.3.2.3, pg. 4-42, last sentence.
Landfarming is indicated to be applicable for soil at Site 2 and sediment at Site 3 and sediment at Site 4. As indicated previously, due to the levels of halogenated VOCs at Site 2, approval for this treatment must be given by the Air Quality Division on a site by site specific basis. Within this discussion the specific contaminants to be considered for landfarming shall be indicated.

ANGRC Response

MPCA has recently informed the Air National Guard that landfarming would no longer be approved at DAFB.

MPCA Modification #18

Table 4.5
Under the Ease of Implementability, the statement that treated water may need permit for discharge to Publicly Operated Treatment Works shall be corrected to read "require an NPDES permit" if discharging to surface water.

ANGRC Response

This correction will be used in the FS Addendum.

MPCA Modification #19

Table 5.1

This table indicates the TCLP criterion for benzene is 5 milligram/liter (mg/l). This should be 0.5 mg/l as indicted in the text in Sections 5.1.2 and 5.1.3. The text shall be modified with this correction.

ANGRC Response

We agree, however alternatives for soils will not require landfarming or disposal. Therefore, TCLP criteria will not be addressed in the FS Addendum.

MPCA Modification #20

Section 5.2.1, pg. 5-10, first paragraph

This section indicates that Alternative S1/W1 will be suitable for soils at Site 8. Due to the levels of TPH contaminated soils above 50 mg/kg, complete rationale for not recommending remediation for these soils shall be presented.

Also in the following paragraph the point is made that no additional capital expense would be expended for this option; this, however, is not true at Site 2 where FAA LOS requirements shall require the installation of additional monitoring points following the remediation and abandonment of the existing monitoring wells at Site 2.

ANGRC Response

See response to modification #6.

The FS Addendum will address additional wells required at Site 2.

MPCA Modification #21

Section 5.2.3, pg. 5.15-5.25
The landfarm option, alternative S3 may be the most cost effective and appropriate treatment for Site 2, Site 3 and Site 8 soils and sediment from Site 3 and Site 4. however, landfarming approval for soils containing trace amounts of higher concentrations of VOCs must be approved through the MPCA Air Quality Division. This may also alter the criteria for landfarming as discussed on pages 5-17 in Section 5.2.3. Sampling and analysis requirements may be modified also by the MPCA as site conditions require. Cleanup standards shall also be modified from the MPCA BTEX landfarm guidance, due to the presence of VOCs, SVOCs and trace levels of pesticides and PCBs.

Soils considered likely for the landfarm option at Site 3 are indicated to be at the pad and the ditch. However, no acknowledgment is given regarding the soil contamination in other "hot spots" at locations away from the pad. Both these soils and the TPH contaminated soils shall be discussed within this section with regards to the landfarm option.

ANGRC Response

See response to modification #17.

MPCA Modification #22

Section 5.2.6, pg. 5-27, first paragraph
There appears to be an apparent contradiction between the estimated time for ground water remediation as discussed in Section 5.2.5 for Site 2 and 3 compared with the shorter

estimates in-Section 5.2.6. The report shall be modified to clarify or address this contradiction.

ANGRC Response

The FS Addendum will address the estimated remediation time for Sites 2 and 3.

MPCA Comment 1

Section 1, Introduction, pg. 1-1, figure 1.1
Why is Site 8 the only site shown on this vicinity map? It would be more appropriate to either show no site locations or show all four sites of concern (but only after reference in the text).

ANGRC Response

It is a typo. We agree it should not be there.

MPCA Comment 2

Section 3.1.3.1, pg. 3-18
A reference is made to toluene concentration at Site 4 in this section. The specific concentration of toluene being referenced should be stated explicitly. Additionally, it may be useful to resample soil areas showing at least the highest levels of toluene, to be able to have more certainty when dismissing the findings of the remedial investigation.

ANGRC Response

We are remediating the soil for BTEX and TPH, this will also take care of any toluene in the soil. As stated ALL soil samples showed toluene, since this field exercise we have stopped using black electrician's tape because of sample contamination by the tape.

MPCA Comment 3

Section 3.1.4.3, pg. 3-22

Lead contamination is reported as high as 190 mg/l. This concentration of 190 mg/l is significantly higher than the ARARs for lead and must be addressed as such.

ANGRC Response

See response to modification #6.

MPCA Comment 4

Section 4.3.1, pg. 4-28

Reference for PCB guidance for cleanup is U.S. Environmental Protection Agency 1990c not 1990b.

ANGRC Response

It will be corrected in the FS Addendum.

MPCA Comment 5

Section 4.3.1, pg. 4-32

January 1991, Release 3 of the Minnesota Department of Health Recommended Allowable Levels for benzene is 0.010 ppm not 0.012 ppm as indicated.

ANGRC Response

The correct Health Risk Limits (HRLs) will be used in the FS Addendum.

MPCA Comm

Section 4.   ;g. 4-32

The prelim. .y screening of alternatives for surface water at Site 4 indicates that no-action would be dependent upon sediment remediation. However, it may also enhance surface water restoration to place an oil-absorbent boom across the channel at the culvert as it flows beneath the taxiways and runway.

ANGRC Response

It may enhance it, but is it necessary?

MPCA Comment 7

Table 5.5, and subsequent tables; pp. 5-19 et seq

The cost estimates presented do not all add up to the totals given. These cost estimates should be reviewed and revised as appropriate.

ANGRC Response

The estimates presented in the FS Addendum will be corrected.

MPCA Comment 8

Table 5.6, pg. 5-22

Depending upon the PCBs and TPHs at Site 8, the cost estimates for Site 8 should be included in the cost estimates.

ANGRC Response

See response to modification #6.

MPCA Comment 9

Section 5.2.6, pg. 5-28

The discussion of optimal destruction of target compounds, such as 1,1,1-TCA is unclear and should be clarified.

ANGRC Response

The discussion in the FS Addendum will be clear.

MPCA Comment 10

Section 6, pp. 6-1 et seq

The recommendations for various sites may need to be modified according to the issues raised before, i.e., LOS for Site 2, and PCB treatment depending upon the correct units of the laboratory results. Since the Minnesota Air National Guard will be providing thermal treatment to a large quantity of BETX contaminated soil, it may be beneficial to explore to possibility of adding the sediment from Site 4 to the soil which will be thermally treated.

ANGRC Response

It will be included in the FS Addendum.

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SECTION 3.0

IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section provides the basis for selecting appropriate remediation technologies and developing remedial alternatives for soil at Sites 3 and 4, and groundwater at Sites 2, 3, and 4. Section 3.1 identifies the ARARs for the sites. Section 3.2 discusses the compounds and media of concern for the sites. Section 3.3 identifies the remedial action objectives. General response actions are identified in Section 3.4. Technologies are identified and screened in Section 3.5

3.1 APPLICABLE OR APPROPRIATE AND RELEVANT REQUIREMENTS

ARARs are environmental and public health standards used to determine the appropriate extent of site cleanup and to develop remedial action alternatives. There are three categories of ARARs as identified by the USEPA: chemical-specific, location-specific, and action-specific requirements. Chemical-specific ARARs have previously been evaluated to serve as remediation goals for the sites (ES 1994). The ARARs which were considered for this FS Addendum include the following:

- Federal Maximum Contaminant Levels (MCLs). These are current federal maximum contaminant levels for drinking water as established under the Safe Drinking Water Act (40 CFR Part 141).

- State of Minnesota Health Risk Limits (HRLs). These are State of Minnesota health risk limits for contaminant concentrations in groundwater as established in Minnesota Rules Chapter 4717.

- State of Minnesota leaching based cleanup goals. These are soil remediation goals based on a contaminants potential to leach to groundwater. These remediation goals are derived pursuant to the "Procedures For Establishing Soil Clean-up Levels" Version 1. The leaching based cleanup goals are presented in Attachment II to an MPCA October 14, 1992 letter. The October 14, 1992 letter is included in Appendix C of this report.

- State of Minnesota Specific Standards of Quality and Purity for Class 2B waters of the State; Aquatic Life and Recreation. These are State of Minnesota limits for quality of water of the state that are necessary for aquatic life and recreation (MN Rules 7050.0222).

Table 3-1 presents the chemical-specific ARARs considered and a summary of the site specific constituents which exceed the ARARs.

3.2 CHEMICALS OF CONCERN

Chemicals of concern (COCs) were identified as those compounds which exceeded the ARARs as presented in Table 3-1. The following sections present the media specific COCs for Sites 2, 3, and 4 at the Minnesota Air National Guard 148th Fighter Wing.

3.2.1 Site 2 Groundwater

In order to monitor the water quality at the site, a groundwater monitoring program is on-going at the site. Based on the results of this monitoring program, only one compound exceeds ARARs in groundwater at Site 2. During the February 1995 groundwater sampling event, five monitoring wells were sampled at Site 2. Cis-1,2-dichloroethene was detected in three monitoring wells (MW-1, GW-2D, GW-2E) or 60% of the groundwater samples collected at Site 2. Concentrations of cis-1,2-dichloroethene were below ARARs in all monitoring wells with the following exception. Cis-1,2-dichloroethene was detected in monitoring well GW-2E in excess of ARARs. This monitoring well is associated with FTA-2 at Site 2. Due to the limited occurrence of this compound in Site 2 groundwater, groundwater is not considered a media of concern for Site 2.

TABLE 3-1

DEVELOPMENT OF MEDIA SPECIFIC REMEDIATION GOALS FOR SITES 2, 3, AND 4
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Constituent [a]	Maximum Concentration [b]	Results of Recent Sampling [c]	ARARs Federal MCL [d] (µg/l)	ARARs Minnesota HRL [e] (µg/l)	ARARs MPCA Soil [f] Clean-up Goal (mg/kg)	ARARs Minnesota Aquatic Life Stds. [g] (µg/l)	Compound Exceeds ARARs
Site 2 - Groundwater (µg/l)							
Benzene	1.2	2.1	5	10	NA	–	
1,2-Dichloroethane	0.22	BDL	–	4	NA	–	
1,1-Dichloroethene	0.61	BDL	7	6	NA	–	
cis-1,2-Dichloroethene	NA	230	70	70	NA	–	YES
trans-1,2-Dichloroethene	1200	18	100	100	NA	–	
Trichloroethene	33	2.1	5	–	NA	–	
Vinyl Chloride	3.1	BDL	2	0.2	NA	–	
Diethyl phthalate	144	–	–	6000	NA	–	
Dimethyl phthalate	63	–	–	–	NA	–	
Site 2 - Surface Water (µg/l)							
trans-1,2-Dichloroethene	2.6	–	–	–	NA	NAv/NAv	
Site 3 - Soil (mg/kg)							
Benzene	0.9	–	–	–	0.5	–	YES
1,1-Dichloroethane	0.022	–	–	–	NE	–	
1,1-Dichloroethene	0.037	–	–	–	NE	–	
trans-1,2-Dichloroethene	0.014	–	–	–	NE	–	
Ethylbenzene	0.26	–	–	–	NE	–	
Tetrachloroethene	0.3	–	–	–	0.6	–	
Toluene	0.74	–	–	–	NE	–	
1,1,1-Trichloroethane	0.21	–	–	–	NE	–	
Trichloroethene	0.94	–	–	–	0.6	–	YES
Xylenes	2	–	–	–	NE	–	
4,4-DDD	0.19	–	–	–	NE	–	
4,4-DDE	0.061	–	–	–	NE	–	
4,4-DDT	0.5	–	–	–	NE	–	
Bis (2-ethylhexyl)phthalate	0.59	–	–	–	NE	–	
PCB 1254	1.1	–	–	–	10	–	
Total BTEX	3.9	–	–	–	5	–	
Total Petroleum Hydrocarbons	2700	–	–	–	50	–	YES
Barium	121	–	–	–	NE	–	
Cadmium	19.4	–	–	–	NE	–	
Chroumium	44.6	–	–	–	NE	–	
Lead	30.3	–	–	–	500	–	
Mercury	0.28	–	–	–	NE	–	
Site 3 - Sediment (mg/kg)							
1,1-Dichloroethane	0.0056	–	–	–	NE	–	
1,1-Dichloroethene	0.018	–	–	–	NE	–	
Tetrachloroethene	0.0051	–	–	–	0.6	–	
1,1,1-Trichloroethane	0.24	–	–	–	NE	–	
Trichloroethene	0.14	–	–	–	0.6	–	
Bis (2-ethylhexyl)phthalate	0.6	–	–	–	NE	–	
Total Petroleum Hydrocarbons	2000	–	–	–	50	–	YES

TABLE 3-1

DEVELOPMENT OF MEDIA SPECIFIC REMEDIATION GOALS FOR SITES 2, 3, AND 4
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM
(continued)

Constituent [a]	Maximum Concentration [b]	Results of Recent Sampling [c]	ARARs: Federal MCL [d] (µg/l)	ARARs: Minnesota HRL [e] (µg/l)	ARARs: MPCA Soil [f] Clean-up Goal (mg/kg)	ARARs: Minnesota Aquatic Life Stds. [g] (µg/l)	Compound Exceeds ARARs
Arsenic	19	-	-	-	NE	-	
Barium	100	-	-	-	NE	-	
Cadmium	7	-	-	-	NE	-	
Chromium	54.6	-	-	-	NE	-	
Lead	478	-	-	-	500	-	
Mercury	0.58	-	-	-	NE	-	
Site 3 - Groundwater (µg/l)							
Benzene	1.1	ND	5	10	NA	-	
1,1-Dichloroethane	250	39	-	70	NA	-	
1,2-Dichloroethane	4.4	ND	5	4	NA	-	
1,1-Dichloroethene	58	10	7	6	NA	-	YES
trans-1,2-Dichloroethene	450	39	100	100	NA	-	
Tetrachloroethene	1000	770	5	-	NA	-	YES
Toluene	36	ND	1000	1000	NA	-	
1,1,1-Trichloroethane	3100	390	200	70	NA	-	YES
Trichloroethene	790	130	5	-	NA	-	YES
Vinyl Chloride	9.1	30	2	0.2	NA	-	YES
Diethyl phthalate	16	-	-	6000	NA	-	
Dimethyl phthalate	18	-	-	70000	NA	-	
Napthalene	22	BEQL	-	300	NA	-	
PCB 1242	45	-	0.5	0.04	NA	-	YES
Total Petroleum Hydrocarbons	ND	1.3	-	-	NA	-	
Barium	1000	-	2000	2000	NA	-	
Chromium	710	-	100	100	NA	-	YES
Lead	30	-	15	-	NA	-	YES
Site 3 - Surface Water (µg/l)							
1,1-Dichloroethene	35	-	-	-	NA	NAv/NAv	
trans-1,2-Dichloroethene	82	-	-	-	NA	NAv/NAv	
Tetrachloroethene	10	-	-	-	NA	8.9/428	
1,1,1-Trichloroethane	1400	-	-	-	NA	263/2628	
Trichloroethene	740	-	-	-	NA	120/6988	
Dimethyl phthalate	12	-	-	-	NA	NAv/NAv	
Total Petroleum Hydrocarbons	1500	-	-	-	NA	NAv/NAv	
Arsenic	20	-	-	-		53/360	
Barium	600	-	-	-	NA	NAv/NAv	
Cadmium	14	-	-	-	NA	NAv/NAv	
Chromium	200	-	-	-	NA	NAv/NAv	
Lead	760	-	-	-	NA	NAv/NAv	
Site 4 - Soil (mg/kg)							
Benzene	6.2	-	-	-	0.5	-	YES
Ethylbenzene	12	-	-	-	NE	-	
Toluene	25	-	-	-	NE	-	
Xylenes	315	-	-	-	NE	-	

TABLE 3-1

DEVELOPMENT OF MEDIA SPECIFIC REMEDIATION GOALS FOR SITES 2, 3, AND 4
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM
(continued)

			ARARs				
Constituent [a]	Maximum Concentration [b]	Results of Recent Sampling [c]	Federal MCL [d] (μg/l)	Minnesota HRL [e] (μg/l)	MPCA Soil [f] Clean-up Goal (mg/kg)	Minnesota Aquatic Life Stds. [g] (μg/l)	Compound Exceeds ARARs
Total BTEX	358.2	–	–	–	5	–	YES
Total Petroleum Hydrocarbons	530	–	–	–	50	–	YES
Barium	91.7	–	–	–	NE	–	
Cadmium	11.5	–	–	–	NE	–	
Chromium	49.3	–	–	–	NE	–	
Lead	7.3	–	–	–	500	–	
Site 4 - Berm Soil (mg/kg)							
Acetone	–	0.66	–	–	NE	–	
n-Propylbenzene	–	1.8	–	–	NE	–	
1,3,5-Trimethylbenzene	–	11	–	–	NE	–	
2-Chlorotoluene	–	1.4	–	–	NE	–	
4-Chlorotoluene	–	1.4	–	–	NE	–	
1,2,4-Trimethylbenzene	–	3.2	–	–	NE	–	
4-Isoproplytoluene	–	5.4	–	–	NE	–	
Napthalene	–	0.18	–	–	NE	–	
Total Petroleum Hydrocarbons	–	510	–	–	50	–	YES
Site 4 - Sediment (mg/kg)							
Benzene	16	–	–	–	0.5	–	YES
Ethylbenzene	400	–	–	–	NE	–	
Toluene	54	–	–	–	NE	–	
Xylenes	690	–	–	–	NE	–	
Total BTEX	1160	–	–	–	5	–	YES
Total Petroleum Hydrocarbons	7000	–	–	–	50	–	YES
Barium	199	–	–	–	NE	–	
Cadmium	1.3	–	–	–	NE	–	
Chromium	23.4	–	–	–	NE	–	
Lead	23.1	–	–	–	500	–	
Site 4 - Groundwater (μg/l)							
Benzene	22	–	5	10	NA	–	YES
trans-1,2-Dichloroethene	5.8	–	100	100	NA	–	
Xylenes	2.7	–	10000	10000	NA	–	
Total Petroleum Hydrocarbons	3240	–	–	–	NA	–	
Barium	170	–	2000	2000	NA	–	
Cadmium	3.1	–	5	4	NA	–	
Chromium	3.9	–	100	100	NA	–	

TABLE 3-1

DEVELOPMENT OF MEDIA SPECIFIC REMEDIATION GOALS FOR SITES 2, 3, AND 4
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM
(continued)

Constituent [a]	Maximum Concentration [b]	Results of Recent Sampling [c]	ARARs: Federal MCL [d] (µg/l)	ARARs: Minnesota HRL [e] (µg/l)	ARARs: MPCA Soil [f] Clean-up Goal (mg/kg)	ARARs: Minnesota Aquatic Life Stds. [g] (µg/l)	Compound Exceeds ARARs
Site 4 - Surface Water (µg/l)							
Benzene	930	–	–	–	NA	114/4487	
trans -1,2-Dichloroethene	5.3	–	–	–	NA	NAv/NAv	
Ethylbenzene	74	–	–	–	NA	68/1859	
Toluene	4.3	–	–	–	NA	253/1352	
1,1,1-Trichloroethane	19	–	–	–	NA	263/2628	
Trichloroethene	22	–	–	–	NA	120/6988	
Xylenes	1020	–	–	–	NA	166/1407	
Total Petroleum Hydrocarbons	2500	–	–	–	NA	NAv/NAv	

Notes: a: Constituent concentrations for detected compounds as identified in FS (ES 1992)
- b: Maximum constituent concentrations are from the FS (ES 1992).
- c: Maximum concentration from the 2/4/95 Sites 2 and 10 groundwater sampling event (Twin Ports Testing 1995) or the 4/6/95 Sites 3 and 4 sampling event (Montgomery Watson). During the 4/6/95 sampling event, groundwater samples were collected from Site 3 and soil samples were collected at Site 4.
- d: Federal MCLs are the current federal maximum contaminant levels for drinking water as established under the Safe Drinking Water Act (40 CFR Part 141).
- e: Minnesota HRLs are the state health risk limits for substances found to degrade Minnesota groundwater as established in the Minnesota Rules Chapter 4717.
- f: Cleanup numbers provided by MPCA. Numbers were reportedly derived using MPCA "Procedures For Establishing Soil Cleanup Levels" Version 1. PCB cleanup value from USEPA Guidance on Remedial Actions for Superfund Sites with PCB contamination.
- g: Aquatic life standards are those presented in Minnesota Rules Chapter 7050.0222 for Class 2B waters. These standards are presented for general comparison purposes only and are included at the request of the MPCA. Values presented are the chronic standard / maximum standard.

BEQL: Below Estimated Quantitation Limit
ND: Not Detected
NA: Not applicable
NE: Not established. Although these constituents were detected in soil and sediment, the concentration levels do not exceed action levels for which reason no MPCA cleanup goals were provided (MPCA 1992).
NAv: Not available
Total petroleum hydrocarbons (TPH) - determined by EPA method 418.1 during remedial investigation.
TPH determined using Wisconsin DRO Method for April 1995 sampling event.

3.2.2 Site 3 Soils and Sediments

The COCs for soil and sediment at Site 3 were identified based on the ARARs listed in Table 3-1. The COCs for soil and sediment include the following:

COC	Maximum Concentration (mg/kg)	Cleanup Goal (mg/kg)
Trichloroethene	0.94	0.6
Benzene	0.9	0.5
Total petroleum hydrocarbons	2,700	50

The cleanup goal presented above is the MPCA soil cleanup goal as presented in their letter dated 14 October 1992. A copy of this letter is included as Appendix C of this report.

3.2.3 Site 3 Groundwater and Surface Water

COCs for Site 3 groundwater are identified as those compounds with concentrations that exceed federal MCLs or Minnesota HRLs. These compounds include:

COC	Maximum (4/6/95 Sampling event) Concentration (µg/l)	Cleanup Standard (µg/l)
1,1-Dichloroethene	10	6
Tetrachloroethene	770	5
1,1,1-Trichloroethane	390	70
Trichloroethene	130	5
Vinyl chloride	30	0.2

The above referenced cleanup standard is either the Federal MCL or Minnesota HRL, which ever is more restrictive.

In samples collected on April 1995 sampling event (Appendix B), some analytes had estimated quantitation limits that were higher than their respective ARAR. This was the result of matrix interferences that required sample dilutions to stay within the calibration range of the analytical instrument. Since analytical results for other wells and analytes had estimated quantitation limits below the ARAR levels, it has been demonstrated that compounds in the samples can be detected and the analytical results are not necessarily suspect.

The existence of surface water at the site is undocumented. Previous investigations reportedly sampled surface water, however it is unknown if the surface water exists on site seasonally or was the result of ponding from recent rainfall events. There are no listed waters of the state in the vicinity of Duluth International Airport. By default, all existing surface water in the vicinity of the airport (Beaver Creek, Miller Creek and Wild Rice Lake Reservoir) is classified as Class 2B. Although elevated concentrations of VOCs have been detected in surface water at the site, all detections are below the maximum standard for Class 2B waters as specified in MN Rules 7050.0222. Based on these considerations, no chemicals of concern are identified for surface water at Site 3.

3.2.4 Site 4 Soil and Sediments

COCs for Site 4 soil and sediment are identified as those compounds which exceed the ARARs listed in Table 3-1. The COCs for soil and sediment include the following:

COC	Maximum Concentration (mg/kg)	Cleanup Standard (mg/kg)
Benzene	16	0.5
Total BTEX	1,160	5
Total Petroleum Hydrocarbons	7,000	50

The cleanup goal presented above is the MPCA soil cleanup goal as presented in their letter dated 14 October 1992. A copy of the 14 October 1992 letter is included as Appendix C of this report.

3.2.5 Site 4 Groundwater and Surface Water

In order to monitor the water quality at Site 4, a groundwater monitoring program is on-going. The most recent results from this monitoring program were compared to ARARs to identify a list of chemicals of concern for groundwater at the site. COCs for Site 4 groundwater were identified based on the ARARs presented in Table 3-1. Contaminants detected at concentrations exceeding the above referenced ARARs were considered COCs. The COCs for Site 4 groundwater include the following:

COC	Maximum Concentration (μg/l)	Cleanup Standard (μg/l)
Benzene	22	5

The above referenced cleanup standard is either the Federal MCL or Minnesota HRL, which ever is more restrictive. Based on the results of the RI, benzene was detected in two of twelve monitoring wells sampled or 17% of the groundwater samples. Only one monitoring well had benzene concentrations in excess of ARARs. Due to the limited occurrence of benzene in water samples collected at Site 4, groundwater is not considered a media of concern at Site 4.

The existence of surface water at the site is undocumented. Previous investigations reportedly sampled surface water, however it is unknown if the surface water exists on site seasonally or was the result of ponding from recent rainfall events. There are no listed waters of the state in the vicinity of Duluth International Airport. By default, all existing surface water in the vicinity of the airport (Beaver Creek, Miller Creek and Wild Rice Lake Reservoir) is classified as Class 2B. Although elevated concentrations of VOCs have been detected in surface water at the site, all detections are below the maximum standard for Class 2B waters as specified in MN Rules 7050.0222. Based on these considerations, no chemicals of concern are identified for surface water at Site 4.

3.3 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) serve as guidelines in the development of remedial action alternatives. RAOs for Sites 3 and 4 soil and sediment were established to mitigate the potential risks associated with accidental ingestion of contaminated soil and sediment. The RAOs for soil and sediment include:

- Reduce contaminant concentrations to below MPCA soil and sediment cleanup levels.

- Prevent direct contact with contaminated soil and sediment and prevent contaminant migration from the soil into groundwater.

The RAOs for Site 2 and 3 groundwater are goals for protecting human health and the environment, preventing or minimizing exposure to contaminants and achieving ARARs to the extent possible. The RAOs for groundwater include the following:

- Reduce contaminant levels to below Federal MCLs
- Reduce contaminants to below State of Minnesota HRLs
- Reduce accidental ingestion of contaminated groundwater
- Minimize the spread of contaminated groundwater.

3.4 GENERAL RESPONSE ACTIONS

General response actions (GRAs) are defined as those measures that will satisfy the RAOs discussed in Section 3.3. These general response actions may be combined to provide the most appropriate remedial action alternative.

3.4.1 General Response Actions for Soil and Sediment

The general response actions for Sites 3 and 4 soil and sediment were previously introduced in the FS and include the following:

- No Action
- Institutional control
- Erosion control
- Containment
- Removal
- Treatment

The reader is referred to the FS for descriptions of the individual general response actions for soil and sediment.

The areas within Site 3 impacted by VOCs include Storage Area C which is an area approximately 90 feet by 120 feet. Since contaminants have impacted groundwater at the site, it is assumed that the entire unsaturated thickness of soil is impacted. Therefore, the depth of contaminated soil is approximately 10 feet. In addition to the storage area, the drainage ditch which runs to the north of the storage area is also impacted. The area of the ditch which is impacted is approximately 200 feet in length and 5 feet wide. Based on the results of previous sampling (ES 1990), the depth of impacted sediment is 1 foot. The total volume of soil and sediment requiring remediation at Site 3 is approximately 4,400 cubic yards. The extent of soil and sediment impacts at Site 3 are presented in Figure 3-1.

Areas impacted by elevated concentrations of VOCs and TPH at Site 4 are primarily limited to the drainage ditches located to the north, west and south of the aboveground fuel storage tanks. The depth of contaminants at the site is limited to the top 1 foot of the sediments. Impacts are spread uniformly along the drainage ditches. In addition to the ditch sediments, several "Hot Spots" of elevated concentrations of total petroleum hydrocarbons are located within Site 4. The depth of soil impacts in these areas is limited to the top 1-foot. Therefore, the total volume of sediment and shallow soil requiring remediation at Site 4 is approximately 227 cubic yards.

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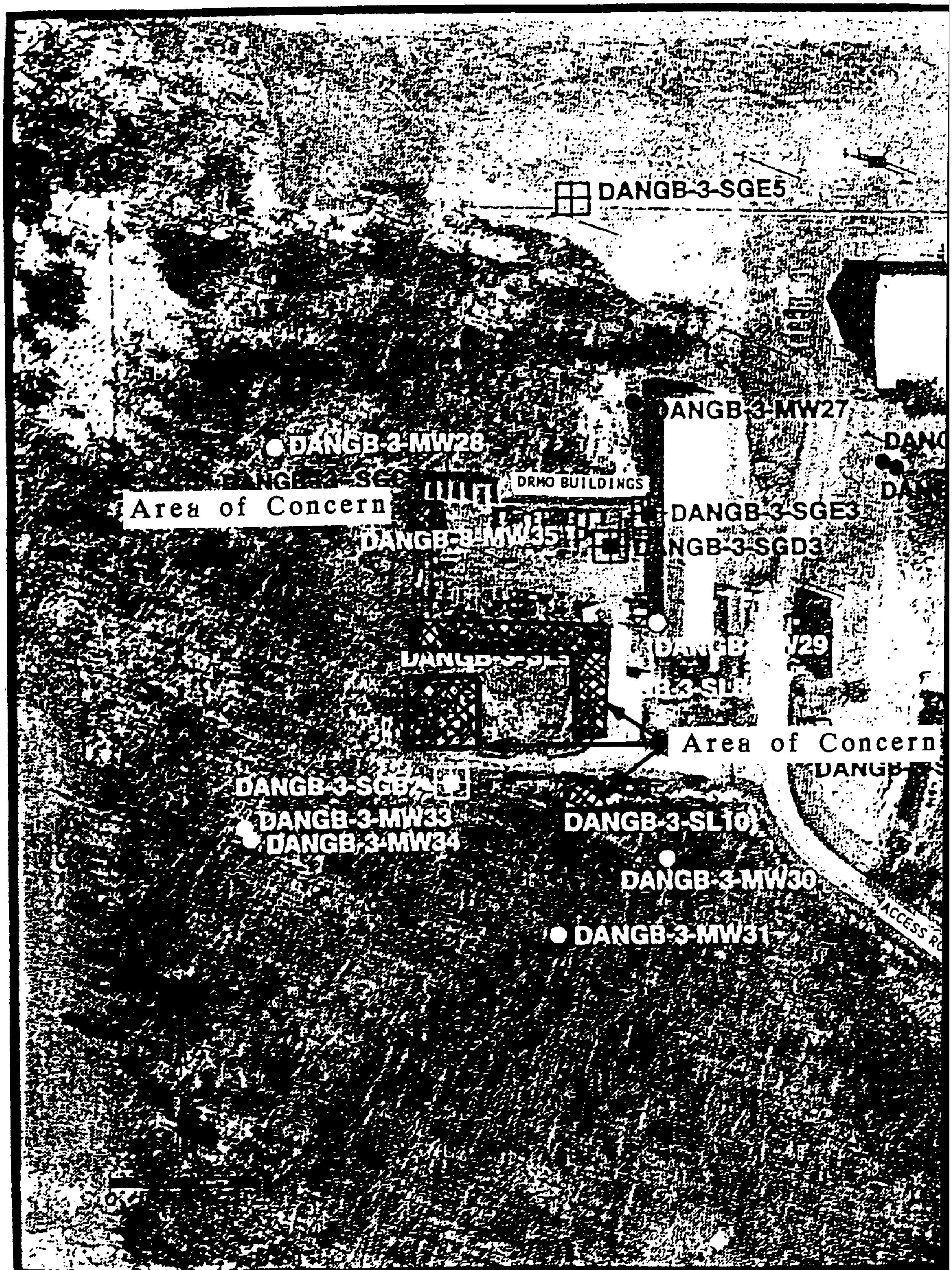
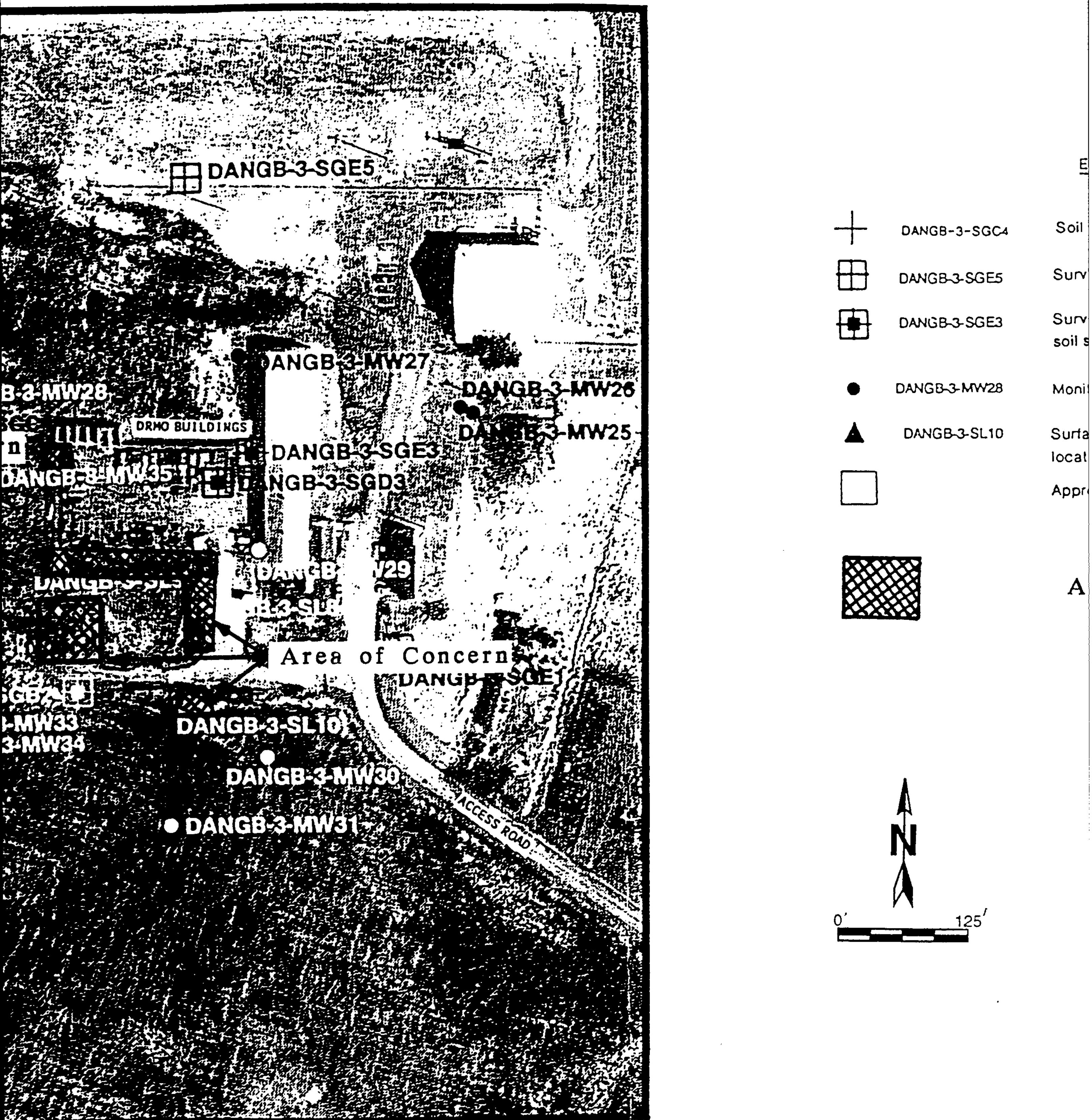


SOURCE: ENGINEERING SCIENCE, INC. 1994


DANGB-3-SGE5
DANGB-3-MW27
B-3-MW28
DRMO BUILDINGS
DANGB-3-MW26
DANGB-3-SGE3
DANGB-3-MW35
NGB-3-SGD3
3-MW25
W29
Area of Concern
DANGB-3-SL10
DANGB-3-MW30
DANGB-3-MW31
-MW33
3-MW34
ACCESS ROAD
DANGB-3-SGC4
Soil
DANGB-3-SGE5
Surv
DANGB-3-SGE3
Surv
soil
DANGB-3-MW28
Moni
DANGB-3-SL10
Surfa
locat
Appr
A
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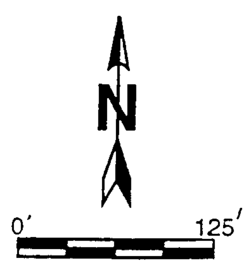
0'
125'

EXPLANATION

+	DANGB-3-SGC4	Soil gas grid point and sampling location.
⊞	DANGB-3-SGE5	Surveyed soil gas grid point.
⊞ (filled center)	DANGB-3-SGE3	Surveyed soil gas grid point and soil sample location.
●	DANGB-3-MW28	Monitoring well, Remedial Investigation.
▲	DANGB-3-SL10	Surface-water and sediment sampling location, Remedial Investigation.
□		Approximate location of Storage Area "C".
▩		Area of Concern



MONTGOMERY WATSON

SITE 3 - AREAS OF CONCERN

MINNESOTA AIR NATIONAL GUARD
DULUTH, MINNESOTA

FIGURE 3-1

Based on the analytical results from the April 1995 sampling event, soils within the berms surrounding the aboveground fuel storage tanks are also impacted. Currently, the nature and extent of contamination within the berms is not well defined. However, it is assumed that the top 1 foot of soil within the berms and the entire volume of the soil used for the construction of the berms is impacted. Therefore, the volume of soil in the bermed area requiring remediation is approximately 4,354 cubic yards. In total, approximately 4,600 cubic yards of soil and sediment require remediation at Site 4. The extent of soil and sediment contamination at Site 4 is presented in Figure 3-2.

3.4.2 General Response Actions for Groundwater

General response actions for Sites 2, 3 and 4 groundwater were also introduced previously in the FS and could include:

- No Action
- Monitoring
- Institutional controls
- Containment
- Removal
- Treatment

The reader is directed to the FS for descriptions of the individual general response actions for groundwater.

3.5 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Technologies were previously identified and screened within the FS. From these technologies, a set of technologies was retained for alternative development and eventual remedy selection. The purpose of the FS Addendum is to identify at least two additional soil and groundwater alternatives and to evaluate these alternatives along with a no-action alternative and the previously selected alternatives for groundwater and soil. To meet this objective, technologies previously identified

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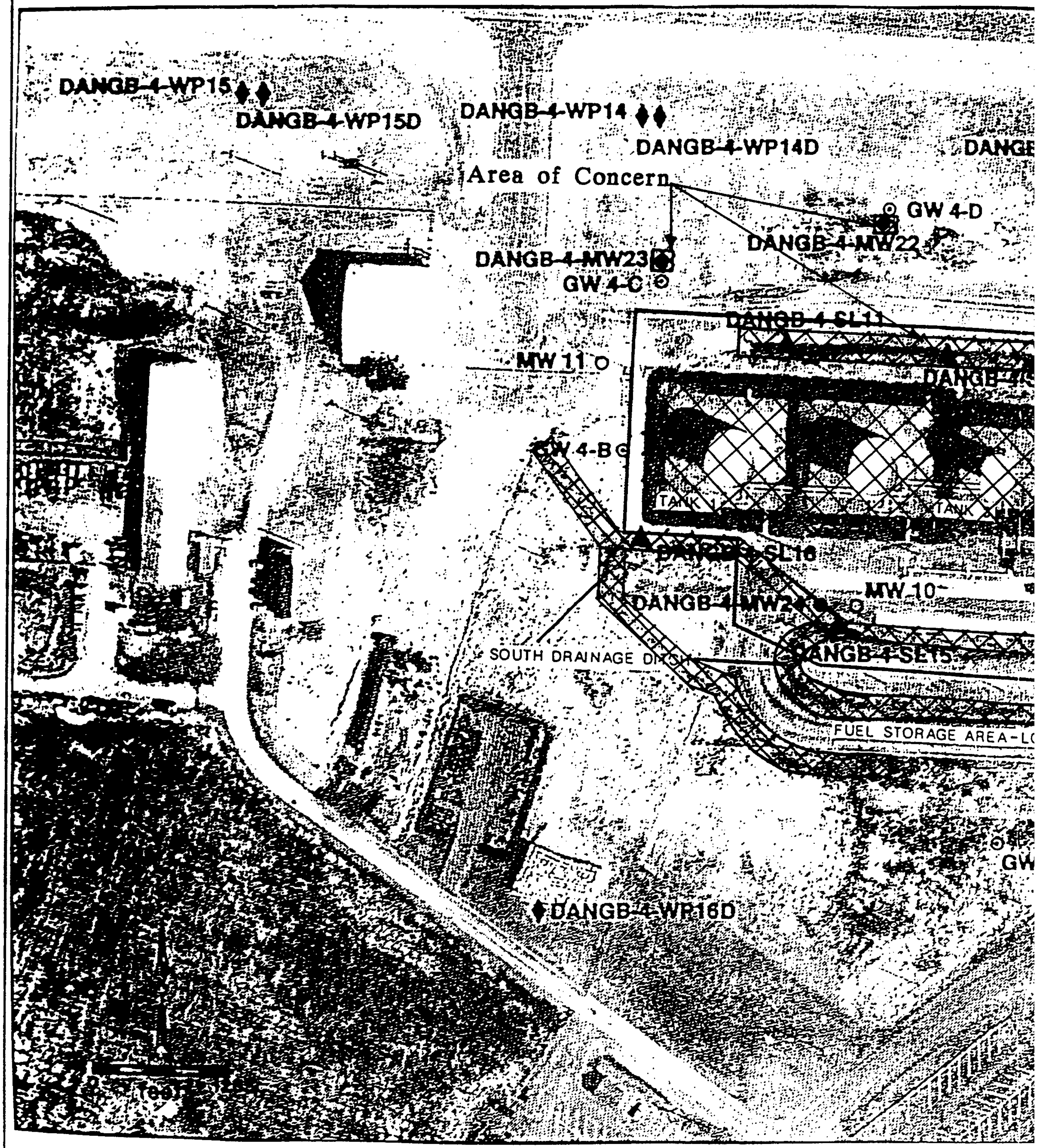
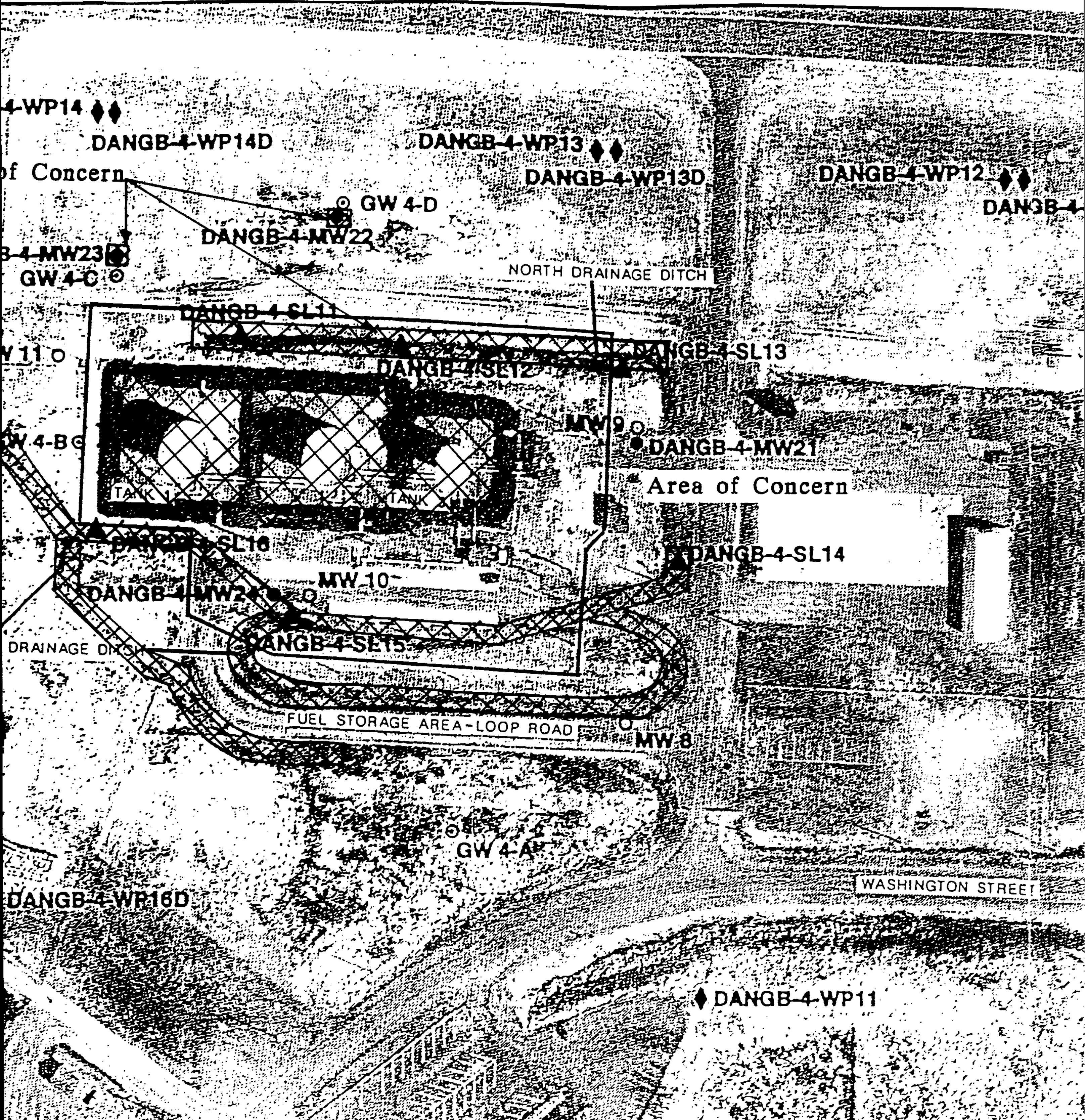
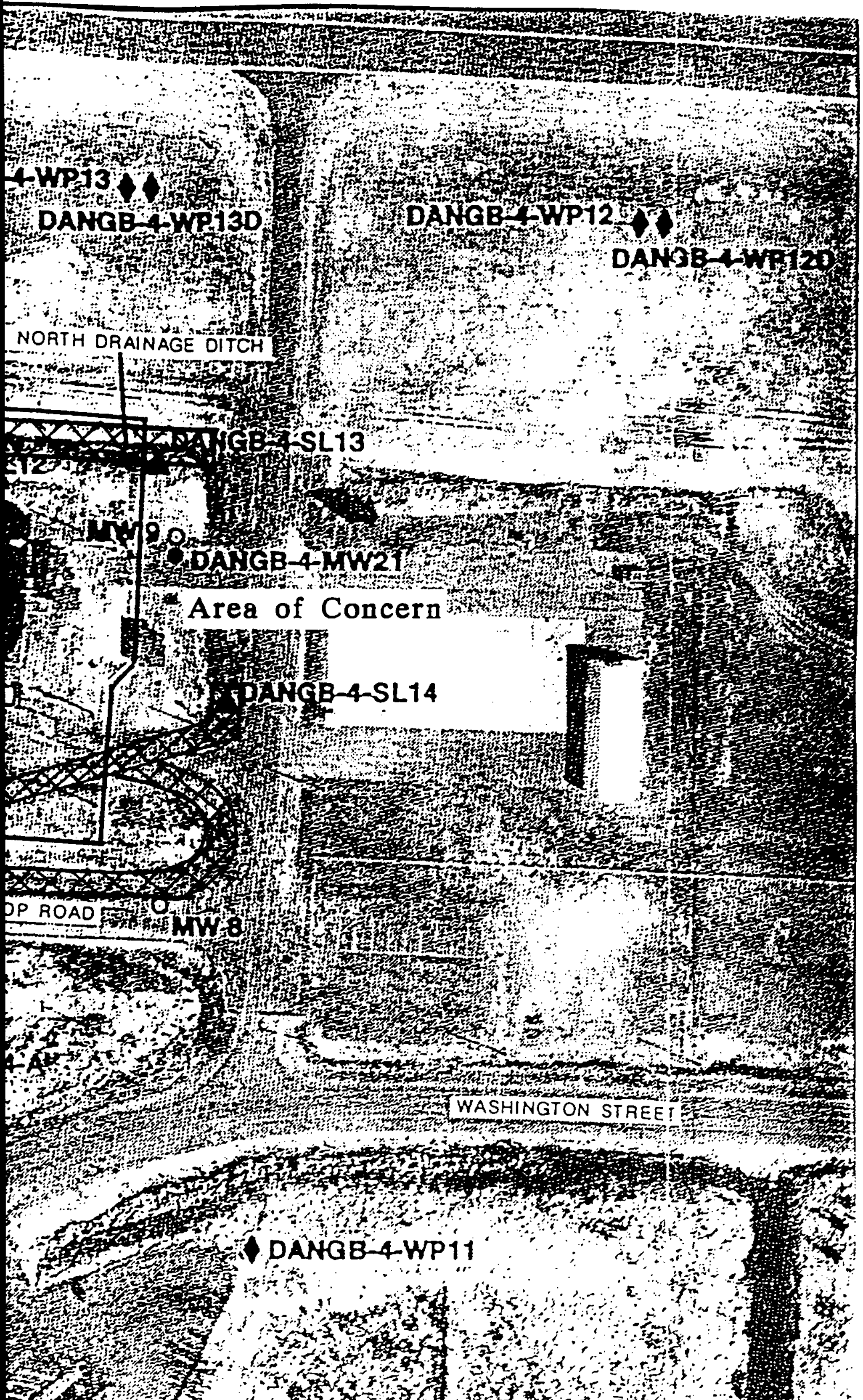


SOURCE: ENGINEERING SCIENCE, INC. 1994



4-WP14
DANGB-4-WP14D
DANGB-4-WP13
DANGB-4-WP13D
DANGB-4-WP12
of Concern
GW 4-D
DANGB-4-MW22
B-4-MW23
GW 4-C
NORTH DRAINAGE DITCH
DANGB-4-SL11
DANGB-4-SL13
DANGB-4-SL12
MW 9
DANGB-4-MW21
W 4-B
Area of Concern
TANK 1
TANK
DANGB-4-SL14
MW 10
DANGB-4-MW24
DRAINAGE DITCH
FUEL STORAGE AREA-LOOP ROAD
MW 8
GW 4-A
WASHINGTON STREET
DANGB-4-WP16D
DANGB-4-WP11



EXPLANATION

GW 4-A	Monitoring well, Phase II, Stage 2.
MW 8	Monitoring well, Phase II, Stage 1.
DANGB-4-MW21	Monitoring well, Remedial Investigation.
DANGB-4-WP12	Well point, Remedial Investigation.
DANGB-4-SL11	Surface-water and sediment sampling location, Remedial Investigation.
	Approximate boundary of Fuel Storage Area (fenced area).
	Area of Concern

N

0′ 125′

MONTGOMERY WATSON

SITE 4 - AREAS OF CONCERN

MINNESOTA AIR NATIONAL GUARD
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FIGURE 3-2

and retained for their applicability and acceptability will be re-evaluated along with newly identified technologies.

Table 3-2 contains a list of all previously evaluated technologies as well as technologies presented in this FS Addendum. Technologies retained in this section will be assembled into an array of alternatives in Section 4. These alternatives are further screened in Sections 4 and 5 with the final selection (remedy) presented in Section 6.

3.5.1 Previously Identified Technologies for Soil Remediation

Process options retained through the FS analysis were:

Deed restrictions
Excavation restrictions
Fencing
Grading and revegetation
Soil capping
Excavating
Off-site disposal
Landfarming
Asphalt incorporation
On-site incineration
Off-site incineration
On-site thermal desorption

A no-action alternative consisting of deed restrictions was carried through the FS but not selected as a preferred alternative. Only excavation, landfarming, grading, and revegetation were selected for the preferred alternative, and is identified in the existing FS as Alternative S3. The rest of the technologies were rejected either during the preliminary screening or during the detailed analysis in the FS. Alternative S3 was selected as the final remedy for Site 2, 3, and 4 soils.

TABLE 3-2

TECHNOLOGY DEVELOPMENT AND SCREENING SUMMARY
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Media	Remedial Action Objectives	General Response Actions	Technology Types	Process Options	Retain
Soils	Reduce contaminant concentrations to below MPCA soil/sediment clean-up levels.	No Action			
	Prevent direct contact with contaminated soil/sediment and prevent contaminant migration from the soil into groundwater.	Institutional Control	Access restrictions	**Fencing**	[2]Yes
		Erosion Control	Surface improvement	**Grading and revegetation**	[2]Yes
		Containment	Horizontal barriers	**Multi-layered cap**	[1]No
				Bituminous concrete cap	No
		Removal	Excavation	**Excavation**	[2]Yes
		Treatment	Biological	**Enhanced in situ biotreatment**	No
				Landfarming	[2]Yes
			Waste fixation	**Asphalt incorporation**	[1]No
				Vitrification	No
				Solidification	No
			Physical treatment	**Soil vapor extraction**	No
				Steam injection	No
				On-site thermal desorption	[1]No
				In situ soil washing	No

TABLE 3-2

TECHNOLOGY DEVELOPMENT AND SCREENING SUMMARY
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM
(Continued)

Media	Remedial Action Objectives	General Response Actions	Technology Types	Process Options	Retain
Soils (Continued)			Thermal treatment	**On-site incineration**	[3]Yes
				Off-site incineration	No
			Disposal	**Waste piles**	No
				On-site disposal facility	No
				Off-site disposal facility	[1]No
Groundwater	Reduce contaminant levels to below Federal MCLs.	No Action			
		Monitoring	Monitoring	**Groundwater Monitoring**	[2]Yes
	Reduce contaminants to below State of Minnesota HRLs.	Institutional Controls	Access restrictions	**Well drilling restrictions**	[2]Yes
				Alternate water supply	[1]No
	Reduce potential accidental ingestion of contaminated groundwater.	Containment	Impermeable barriers	**Slurry wall**	No
	Minimize the spread of contaminated groundwater.		Hydraulic control	**Interceptor trench**	No
		Removal	Extraction	**Groundwater pumping**	No
				Interceptor trench	[2]Yes
		Treatment	Biological	**Enhanced bioremediation**	No
			Physical	**Precipitation**	No
				Air stripping	[1]Yes

TABLE 3-2

TECHNOLOGY DEVELOPMENT AND SCREENING SUMMARY
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM
(Continued)

Media	Remedial Action Objectives	General Response Actions	Technology Types	Process Options	Retain
Groundwater (Continued)				**Carbon adsorption**	[1]Yes
				Oil-water separation	No
				Ion exchange	No
				Reverse osmosis	No
				Filtration	[1]No
				Carbon adsorption treatment beds	No
				UVB wells	Yes
				Metal Enhanced Reductive Dehalogenation	Yes
			Chemical	**Ultraviolet photolysis and oxidation**	[2]Yes
			Disposal	**Groundwater recharge**	No
				Surfacewater discharge	No
				POTW	[3]Yes

Notes: **Process Options denote those technologies presented in the FS.**
[1] Technology retained but not selected as part of the final recommended remedy in the FS.
[2] Technology retained and selected as part of the final recommended remedy in the FS.
[3] Technology not retained or selected in the FS but included for the FS Addendum.

Since the writing of the FS, soils from Site 2 have been excavated and are currently stored at the Airport. These soils are awaiting treatment. The treatment of these soils is beyond the scope of this FS Addendum

On-site landfarming is no longer possible due to regulatory restrictions against multiple applications on the same site and the presence of chlorinated compounds in site soils. Landfarming off site will be retained within this FS Addendum as a viable technology although the ultimate application of this technology is also limited due to the presence of chlorinated compounds.

3.5.2 Previously Identified Technologies for Groundwater

Process options retained through the FS analysis were:

- Groundwater monitoring
- Drilling restrictions
- Alternate water supply
- Slurry wall
- Groundwater pumping
- Interceptor trench
- Enhanced bioremediation
- Precipitation
- Air stripping
- Carbon adsorption
- Oil-water separation
- Ion exchange
- Reverse osmosis
- Filtration
- Carbon adsorption treatment beds
- Ultraviolet photolysis and oxidation
- Groundwater recharge
- Surface water discharge
- POTW

The selected remedy for groundwater at Sites 2 and 3 in the FS was Alternative W5, interceptor trench with treatment by ultraviolet photolysis and oxidation and disposal to a nearby stream, in addition to Alternative W1 which included groundwater monitoring. Additional work following the FS determined that ultraviolet photolysis and oxidation technology was inappropriate for the site conditions. Subsequent design documents (ES 1994) call for a interceptor trench (or french drain) with treatment of collected groundwater by granular activated carbon (GAC) adsorption. This design also calls for disposal to a POTW. While the design basis for the french drain system has changed, the modified alternative which includes an alternate treatment technology will be retained and re-evaluated along with two additional process options.

3.5.3 Identification of Additional Soil Technologies

This FS Addendum will present two additional process options to be evaluated for soils treatment. While both of these technologies were presented and eliminated as process options in the FS, a re-evaluation is necessary to more fully access the viability of these technologies at the site.

3.5.3.1 On-site Incineration. Thermal incineration either effectively destroys hydrocarbons or desorbs hydrocarbons from soil particles by processing soils through a burner capable of operating at 950°-1050°F. Past concerns with using incineration for soils containing chlorinated compounds was the production of daughter products of the chlorinated compounds, such as dioxins which were then discharged to the air. Recent modifications in incineration technology provide for an afterburner to effectively destroy airborne residual contaminants. Field tests have shown complete destruction of chlorinated compounds using an afterburner operating at a temperature of approximately 2200° F with a two second retention time. A typical operation can process on site up to 16 tons an hour of moist soils at a cost of approximately $100 per ton. These costs do not reflect mobilization to the job site and are dependent upon the total volume of soils to be treated.

The MPCA is currently reviewing an application for a general permit to incinerate soils containing chlorinated compounds. It is expected that a local contractor will soon have this capability and this technology will be available for use in the state of Minnesota. Given the effectiveness,

implementability, and cost of this option, the incineration process will be retained for alternative development and evaluation.

3.5.3.2 Enhanced Volatilization and Biotreatment. Similar to landfarming, the combination of enhanced volatilization and biotreatment technologies will allow for both removal of chlorinated compounds through volatilization and the biodegradation of petroleum hydrocarbons. A lined treatment cell would be constructed in which to place soils for the period of treatment. Soils would be excavated, shredded, and combined with nutrients and bulking agents prior to placement in the treatment cell. The treatment cell would contain perforated piping manifolded to a blower to pull fresh air through the soils. Air from the soil pile would be treated by GAC prior to discharge. In addition, the soil would be irrigated by water to provide optimum soil moisture for biodegradation of contaminants. Leachate water would be collected, treated, and reused in the treatment process.

VOCs, including the chlorinated compounds present in Site 3 soils, are expected to volatilize in the soil treatment bed and be removed by the GAC treatment units connected to the blower. Semi volatile contaminants would readily degrade in the oxygen- and nutrient-rich soil bed. Soil treatment would be closely monitored by conducting respiration tests on the soil bed as well as taking influent and effluent samples from the GAC treatment units. After treatment these soils would be returned to the excavated areas.

Typical costs for aboveground soil treatment ranges from $20 to $50 a ton. Given the reasonable effectiveness, implementability, and cost of this option, the aboveground biotreatment process will be retained for alternative development and evaluation.

3.5.4 Identification of Additional Groundwater Technologies

Three new process options are introduced for groundwater. Two of these process options, funnel and gate containment technology and metal enhanced reductive dehalogenation (MERD) treatment technology, are presented as technologies to work in tandem for in-situ treatment of groundwater. The MERD technology, as presented in Section 4, includes construction of a funnel and gate.

3.5.4.1 Funnel and Gate. This technology is utilized as a containment strategy for groundwater. The technology comprises installation of a cutoff wall to hydraulically contain groundwater. Cutoff walls have been successfully constructed as slurry walls, sheet pile walls, and vertically installed geotextile liners. For the purposes of costing and evaluation, sheet piling with sealed joints to create an impermeable wall is assumed for a typical cutoff wall construction. Sheet pile walls have been successfully installed up to depths of 100 feet deep, do not create fines as with slurry walls, and are readily engineered and constructable.

The cutoff wall is arranged to create a funnel in which groundwater flow is directed to a treatment cell. The layout of the funnel design is designed to provide sufficient containment throughout the contaminant plume while also providing groundwater flow characteristics (i.e., retention time) across the gate to allow sufficient treatment by either in-situ or ex-situ means. Some of the practical in-situ applications for a funnel and gate system may include precipitation, biodegradation, abiotic degradation, or air sparging.

An important aspect of constructing a funnel and gate system is a thorough understanding of site geology and hydrogeology. Groundwater modeling is used to verify viable funnel and gate designs. Costs for funnel and gate technology in combination with MERD technology will be developed in Section 4. Given the reasonable effectiveness and implementability of this option, the funnel and gate process option will be retained for alternative development and evaluation.

3.5.4.2 Metal Enhanced Reductive Dehalogenation Cell. MERD technology is an abiotic oxidation and reduction process that has shown considerable promise in degrading chlorinated compounds. MERD has been applied as a water treatment process for pumping applications and as an in-situ process option. Metal, typically zero valence iron, is used as a reactant to degrade chlorinated hydrocarbons to ethene and chlorine ions. The uniqueness of this technology is the ability to degrade contaminants in-situ without any mass transfer.

In conjunction with a funnel and gate design, a reaction cell within the gate can be constructed of iron filings to create a matrix that degrades dissolved chlorinated VOCs. Batch studies and field tests are necessary to determine contaminant removal rates and water quality constraints. By-products such as vinyl chloride, formed within the reaction cell, should degrade completely if

retention times are sufficient. Other problems dealing with water quality such as iron fouling and precipitation need to be resolved before construction of a full-scale system.

Few in-situ MERD reaction cells have been installed for groundwater restoration. This technology, while considered experimental at this time, may provide a long-term passive remedy to site groundwater. Costs of MERD technology will be developed in Section 4. Given the possibility for an effective and implementable remedy, the MERD process option will be retained for alternative development and evaluation.

3.5.4.3 (Unterdruck-Verdampfer-Brunnen (UVB) Wells. UVB (or vacuum vaporizer well) is an in-situ process consisting of a groundwater well containing an air stripping reactor, with aboveground blowers and air treatment systems. In a standard configuration, a vacuum blower is used to draw clean air down into the well and through a stripping reactor. The air-lift action effects a vacuum in the well inducing a water current. This current passes water into the bottom of the well and, through screen design, out of the top of the well. A sphere of influence is projected into the aquifer where treated groundwater is recirculated. Groundwater contaminants are treated by a phase transfer from groundwater to air.

The sphere of influence expected from a UVB well has reportedly been approximately 2.5 times the saturated length of the well (Langley, 1994). Given that the aquifer within Site 3 has a saturated thickness of 20 feet, a UVB well would be expected to have a 50 foot radius of influence. The actual sphere of influence for a UVB well is highly dependent upon aquifer specific parameters such as hydraulic conductivity, hydraulic gradient, and the degree of anisotropy. From values published in the Feasibility Study, transmissivity values from Site 3 ranged from 1.2 to 37.4 gallons per day per foot (gpd/ft). With a transmissivity value close to 1.2 gpd/ft, an extraction well (recirculating or not) would barely produce water. Even with a transmissivity value of 37.4 gpd/ft, the sphere of influence for a UVB well would develop over an extended time period (months). While application of radial unsteady flow equations is complicated due to the recirculatory nature of the UVB well, the dynamics of the flow system and the limitations of moving water through impermeable materials still apply. Therefore, it is very difficult to predict the number of UVB wells that would be required to achieve full capture of groundwater. Air treatment could be accomplished with GAC.

Costs for UVB are approximately $100,000 per well which includes three years of operation. Given the improbability of a well to capture contaminated groundwater in a timely fashion, this technology will not be retained for alternative development in Section 4.

SECTION 4.0

DEVELOPMENT AND SCREENING OF ALTERNATIVES

In this section, technologies selected in Section 3 as applicable to GRAs and considered technically feasible are assembled into a range of area-specific remedial options. These alternatives are evaluated on the basis of effectiveness, implementability, and cost prior to a detailed analysis in Section 5.

4.1 APPROACH TO THE DEVELOPMENT AND SCREENING OF ALTERNATIVES

Table 4-1 presents a summary of the technologies for soil and groundwater retained for Sites 2, 3, and 4.

For each of the sites, technologies are assembled into alternatives representing a range of treatment and containment combinations. Alternatives include treatment as the principal element to reduce or eliminate the need for long-term management as well as other technologies that involve little or no treatment but provide protection to human health and the environment by preventing or controlling exposure. A no-action or limited-action alternative is included for each site in this FS Addendum. In the cases where an array of alternatives is presented for a site, the no-action alternative serves as a baseline to which other alternatives will be compared. Each of the alternatives are described in detail in Section 4.2.

Following development, each alternative is defined with respect to specific objectives, media, COCs, conceptual plan, regulatory considerations, and other aspects necessary to evaluate the alternative and estimate its cost. A subsequent evaluation of each alternative is conducted with respect to effectiveness, implementability, and cost. These three criteria are defined as follows:

Effectiveness. The effectiveness of each alternative is assessed by evaluating whether it adequately protects human health and the environment during the short term and long term, complies with ARARs, and significantly and permanently reduces the toxicity, mobility, or volume of hazardous substances.

TABLE 4-1

TECHNOLOGY MATRIX
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

	Areas of Concern		
Retained Technology	**Site 2**	**Site 3**	**Site 4**
Soils			
Institutional Control			
Fencing		X	X
Erosion Control			
Grading and revegetation		X	X
Removal			
Excavation		X	X
Treatment			
Landfarming		X	X
On-site incineration		X	X
Groundwater			
Monitoring			
Groundwater monitoring	X	X	
Institutional Control			
Drilling restrictions		X	
Containment			
Interceptor trench		X	
Treatment			
Carbon adsorption		X	
MERD		X	
Disposal			
POTW		X	

Implementability. The implementability of each alternative is evaluated by considering technical feasibility, administrative feasibility, and availability of services and materials.

Cost. The cost of implementing a remedial alternative is considered as a final factor. The capital, operation, and maintenance costs are estimated to within an accuracy of +50% to -30% for each alternative. In addition, a present-worth cost analysis is conducted for each alternative using an 8% discount rate and a 30-year maximum project life.

Alternatives considered to be effective, implementable, and cost feasible are retained for further analysis in Section 5. In Section 5 a detailed analysis of each alternative is conducted using the following nine criteria as directed by CERCLA: short-term effectiveness; long-term effectiveness; implementability; cost; reduction of toxicity, mobility, or volume; compliance with ARARs; overall protection of human health and the environment; state acceptance; and community acceptance.

4.2 SCREENING OF ALTERNATIVES

Alternatives for soil and groundwater are evaluated for all sites requiring treatment. A single limited action alternative is applied for those sites that have been determined to not require treatment of either groundwater or soils.

4.2.1 Site 2

Site 2 consists of FTA-1 and FTA- 2. As discussed in Section 1, no further action was approved for FTA-1 by the MPCA (MPCA 1992). Contaminated soils from FTA-2 have already been excavated and are stored at the Airport. The scope of this FS Addendum does not address treatment alternatives for these soils. Corrective action alternatives developed for Site 2 were based on the assumption that groundwater restoration will meet ARARs. The analytical results of the February 1995 groundwater samples collected from Site 2 monitoring wells indicate that only one compound of interest, cis-1,2-dichloroethene, is exceeding ARARs. Development of an array of alternatives was not undertaken for Site 2 groundwater given this single exceedance. Without the probable requirement for any further action to cleanup or restore

Site 2 soils and groundwater, only a single no-action alternative is presented for groundwater. This alternative provides for groundwater monitoring and site closure.

4.2.1.1 Alternative GW(1): No Action. The only elements included in the no-action alternative are:

- Groundwater monitoring
- Site closure

Under the no-action alternative, a groundwater monitoring program would be implemented to detect changes in the groundwater contaminant plume. Monitoring will include quarterly sampling for all wells. Results from four consecutive well samplings which indicate that all concentrations of chemicals of interest are below the ARARs will be used to propose site closure. An evaluation of effectiveness, implementability, and cost follows:

Effectiveness. Under this scenario, human exposure is unlikely. Potable water for the Airport is supplied by the city. There are no known wells that are impacted or could conceivably become impacted near Site 2. While the toxicity, mobility, or volume of contaminants would not be reduced by treatment, it is likely that contaminants are naturally attenuating. Further sampling will verify the fate of site contaminants.

Implementability. A no-action alternative is easily implemented. This alternative would require some long-term management and groundwater monitoring.

Costs. The costs associated with the no-action alternative include groundwater monitoring. The cost of this alternative is low relative to the other alternatives. The present worth cost for one year of groundwater monitoring is $62,320, as shown in Table 4-2.

The no-action alternative will be retained for further detailed analysis.

TABLE 4-2

SITE 2
COST ESTIMATE FOR ALTERNATIVE 1: GROUNDWATER MONITORING
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Item/Description	Quantity	Unit	Unit Cost	Total Cost
CAPITAL COSTS				
SAMPLING				
Groundwater Sampling and Analytical	4	round	$6,375	$25,500
Construction Management (10%)				$2,550
	Subtotal Construction Costs (CC)			$28,050
Engineering (8% of CC)				$2,244
Permitting (10% of CC)				$2,805
Contingency (20% of CC)				$5,610
	TOTAL CAPITAL COSTS			$38,709
ANNUAL OPERATING AND MAINTENANCE				
Groundwater Sampling and Analytical	4	round	$6,375	$25,500
PRESENT WORTH				
Interest Rate	8%			
Replacement Interval	1			
	TOTAL PRESENT WORTH			$62,320

4.2.2 Site 3

Site 3 contains contaminated soils and groundwater which were likely the result of surface spills related to chemical storage at the DRMO. Alternatives developed for Site 3 were based on the assumption that groundwater restoration and soils treatment will meet ARARs. Given cleanup objectives for Site 3, the following chemicals of concern are identified for site soils:

Benzene
Trichloroethene

Total petroleum hydrocarbons in soils and sediments were also in exceedance of ARARs for Site 3. The following chemicals of concern are identified for site groundwater:

1,1-Dichloroethene
Tetrachloroethane
1,1,1-Trichloroethane
Tetrachloroethane
Vinyl Chloride

Three alternatives for Site 3 groundwater, GW(1) No Action; GW(2) French Drain; and GW(3) MERD, along with four alternatives for Site 3 soils, S(1) Institutional Controls; S(2) Landfarming; S(3) Incineration; and S(4) Aboveground Bioremediation, are presented in this section. Groundwater alternatives are evaluated separately from soil alternatives. The final remedy presented in Section 6, consists of the combination of a groundwater alternative and a soil alternative.

Site 3 alternatives are screened against the criteria of effectiveness, implementability, and cost as defined in Section 4.1. The following sections detail the screening process for each alternative.

4.2.2.1 Alternative GW(1): No Action. The only elements included in the no action alternative are:

- Groundwater monitoring
- Site review

The no-action alternative is used as a baseline for comparison with other alternatives. Under this alternative, no work to reduce the exposure of contaminants to populations or protect the environment from degradation would be undertaken. Since contaminants would remain in the area of concern, the site would require reviews to ensure that a direct exposure to populations was not occurring. An evaluation of effectiveness, implementability, and cost follows:

Effectiveness. Under this scenario, human exposure to site groundwater contaminants is unlikely. Potable water for the Airport is supplied by the city. The toxicity, mobility, or volume of groundwater contaminants would not be reduced.

Implementability. A no-action alternative is easily implemented. Long-term management, reviews, and groundwater monitoring would be required due to contaminated materials left in place.

Costs. Costs associated with the no-action alternative would include groundwater monitoring and reviews. The cost of this alternative is low relative to the other alternatives. The present worth cost for one year of groundwater monitoring is $133,438, as shown in Table 4-3.

The no-action alternative will be retained for further detailed analysis.

TABLE 4-3

SITE 3
COST ESTIMATE FOR ALTERNATIVE 1: GROUNDWATER MONITORING
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Item/Description	Quantity	Unit	Unit Cost	Total Cost
CAPITAL COSTS				
SAMPLING				
Groundwater Sampling and Analytical	4	round	$13,650	$54,600
Construction Management (10%)				$5,460
	Subtotal Construction Costs (CC)			$60,060
Engineering (8% of CC)				$4,805
Permitting (10% of CC)				$6,006
Contingency (20% of CC)				$12,012
	TOTAL CAPITAL COSTS			$82,883
ANNUAL OPERATING AND MAINTENANCE				
Groundwater Sampling and Analytical	4	round	$13,650	$54,600
PRESENT WORTH				
Interest Rate	8%			
Replacement Interval	1			
	TOTAL PRESENT WORTH			$133,438

4.2.2.2 Alternative GW(2): French Drain. The intent of Alternative GW(2) is to eliminate exposure, prevent groundwater VOC plume migration, and advance groundwater restoration. The major elements of this alternative include:

- Groundwater monitoring
- Well drilling restrictions
- Interceptor trench
- Carbon adsorption treatment
- Surface water discharge

This alternative includes groundwater monitoring similar to the no-action alternative in addition to institutional and engineering controls. Institutional controls under this alternative include well drilling restrictions. Groundwater removal under this alternative would consist of a french drain pumping system installed at the downgradient extents of the Site 3 groundwater plume. Pumped groundwater would be treated by the carbon adsorption process retained in Section 3. In the technology screening presented in the feasibility study (ES 1992), a number of treatment options were evaluated in addition to carbon adsorption. These included air stripping and UV oxidation. Air stripping was previously eliminated from consideration due to the low influent flow rate expected at the site. In addition, it was determined that costs for system maintenance would be high due to fouling of the air stripper. UV oxidation was carried as the preferred alternative for groundwater treatment in the FS (ES 1992). However, it was determined that UV oxidation would not be cost effective at the anticipated flow rates and the concentrations of dissolved minerals in site groundwater would foul the system thereby reducing efficiency. Treated water would be discharged to a POTW. The performance of the groundwater removal remedy would be evaluated through groundwater monitoring. An evaluation of effectiveness, implementability, and cost follows:

Effectiveness. Under this scenario, human exposure would be eliminated. The toxicity, mobility, or volume of contaminants would be reduced through treatment. This action will accelerate the rate of groundwater restoration throughout the site by minimizing the migration of contaminants beyond the current extents of the groundwater VOC plume. The performance of Alternative GW(2) may be enhanced through the addition of longitudinal drains, however, due to

site-specific geologic (dominant soil type is glacial till) and hydrogeologic conditions (low transmissivity and permeability) the addition of the longitudinal drains may not significantly decrease remediation times or be cost effective. At the time of remedial design the remediation contractor may, at his discretion, model the effects of the addition of longitudinal drains.

Implementability. The institutional and engineering controls in this alternative are implementable. Contractors and materials required for this alternative are readily available. This alternative would require long-term management, groundwater monitoring, and performance evaluations.

Costs. Costs associated with Alternative GW(2) would include institutional controls, construction, operations, and groundwater monitoring. The cost of this alternative is moderate relative to the other alternatives. The present worth cost over the 15 year expected life of the system is $1,004,130, as shown in Table 4-4.

The Alternative GW(2) will be retained for further detailed analysis.

4.2.2.3 Alternative GW(3): MERD. The intent of Alternative GW(3), like Alternative GW(2), is to eliminate exposure, prevent groundwater VOC plume migration, and advance groundwater restoration. The major elements of this alternative include:

- Groundwater monitoring
- Well Drilling restrictions
- Construct funnel and gate
- Construct MERD reaction cell

Effectiveness. Under this scenario, human exposure would be eliminated. The toxicity, mobility, or volume of contaminants would be reduced through treatment. This action will accelerate the rate of groundwater restoration throughout the site by minimizing the migration of contaminants beyond the current extents of the groundwater VOC plume.

TABLE 4-4

SITE 3
COST ESTIMATE FOR ALTERNATIVE 2: FRENCH DRAIN
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Item/Description	Quantity	Unit	Unit Cost	Total Cost
CAPITAL COSTS				
SAMPLING				
Groundwater Sampling and Analytical	4	round	$13,650	$54,600
RESTRICTIONS/PERMITS				
Drilling Restrictions	1	LS	$5,000	$5,000
NPDES Permit	1	LS	$2,500	$2,500
INTERCEPTOR TRENCHES				
Interceptor Trench Construction	1	LS	$105,000	$105,000
Geotextile	290	sy	$1	$290
Backfill (3/4" to 1 1/2" washed stone)	175	cy	$25	$4,375
Corrugated metal pipe for sumps	60	lf	$27	$1,620
Submersible pump	2	ea	$3,500	$7,000
2" double wall PVC pipe	620	lf	$4	$2,170
1" PVC pipe	40	lf	$0.25	$10
Trenching for piping	620	lf	$25	$15,500
GROUNDWATER TREATMENT				
Prefabricated Structure	1	LS	$32,000	$32,000
Holding tank - 500 gallon	1	LS	$1,500	$1,500
Tank Instrumentation	1	LS	$1,500	$1,500
Flow Meters	2	ea	$250	$500
Pump	1	ea	$500	$500
Bag Filter	1	ea	$500	$500
Bags	5	ea	$6	$30
GAC	3	ea	$1,050	$3,150
PVC valves	1	ea	$210	$210
Controller	1	ea	$4,000	$4,000
Discharge piping	500	lf	$500	$250,000
Trenching for piping	500	lf	$25	$12,500

TABLE 4-4

SITE 3
COST ESTIMATE FOR ALTERNATIVE 2: FRENCH DRAIN
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM
(Continued)

Item/Description	Quantity	Unit	Unit Cost	Total Cost
Construction Management (10%)				$50,446
	Subtotal Construction Costs (CC)			$554,901
Engineering (8% of CC)				$44,392
Permitting (10% of CC)				$55,490
Contingency (20% of CC)				$110,980
	TOTAL CAPITAL COSTS			$765,763
ANNUAL OPERATING AND MAINTENANCE				
Annual Groundwater Monitoring	1	LS	$54,600	$54,600
System Performance Monitoring				
Treatment costs	1	LS	$100,000	$100,000
Influent/Effluent Monitoring	1	LS	$6,200	$6,200
Solids Disposal	1	LS	$2,575	$2,575
	TOTAL ANNUAL COSTS			$163,375
PRESENT WORTH				
Interest Rate	8%			
Replacement Interval	15			
	TOTAL PRESENT WORTH			$1,004,130

Implementability. The institutional and engineering controls in this alternative are implementable. The sheet piling for the funnel and gate is a patented technology and would require obtaining the rights for usage in this application. Contractors and materials required for this alternative would likely be obtained from outside the region. Use of MERD for in-situ

applications has been very limited and is considered an experimental technology. The effects of mineral precipitation and the overall life of a MERD reaction cell are unknown at this time. This alternative would require laboratory and field pilot studies, long-term management, groundwater monitoring, and performance evaluations.

Costs. Costs associated with Alternative GW(3) would include institutional controls, construction, operations, and groundwater monitoring. The cost of this alternative is high relative to the other alternatives. The 30-year present worth cost, as shown in Table 4-5, is $1,721,407.

The Alternative GW(3) will be retained for further detailed analysis.

4.2.2.4 Alternative S(1): Institutional Controls. Alternative S(1) provides for better protection to the public from exposure to Site 3 contaminants than a no-action alternative. The major elements of this alternative include:

- Fencing

Fencing around the site would provide an institutional control limiting access to the site. Currently fencing installed around Site 3 would require upgrading to meet USEPA guidance and sufficiently secure the site from public entry. An evaluation of effectiveness, implementability, and cost follows:

Effectiveness. Under this scenario, human exposure would be limited. The toxicity, mobility, or volume of contaminants would not be reduced. Soil contamination may continue to leach chemicals into the groundwater.

Implementability. This alternative is easily implementable. This alternative would require long-term management due to contaminated materials left in place.

TABLE 4-5

SITE 3
COST ESTIMATE FOR ALTERNATIVE 3: MERD
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Item/Description	Quantity	Unit	Unit Cost	Total Cost
CAPITAL COSTS				
SAMPLING				
Groundwater Sampling and Analytical	4	round	$13,650	$54,600
RESTRICTIONS/PERMITS				
Drilling Restrictions	1	LS	$5,000	$5,000
FUNNEL AND GATE				
Mobilization (dozer)	1	LS	$1,000	$1,000
Clear and Grub	1	acre	$2,800	$2,800
Mobilization (pile driving equipment)	1	LS	$7,200	$7,200
Pile Drive Test	1	LS	$130,000	$130,000
Sheet Piles	30000	sf	$20	$589,500
Monitoring wells	6	ea	$2,000	$12,000
Groundwater Modeling	1	LS	$25,000	$25,000
GROUNDWATER TREATMENT				
Treatability study	1	LS	$81,000	$81,000
Treatment media	1	LS	$25,000	$25,000
Construction Management (10%)				$93,310
	Subtotal Construction Costs (CC)			$1,026,410
Engineering (8% of CC)				$82,113
Permitting (10% of CC)				$102,641
Contingency (20% of CC)				$205,282
	TOTAL CAPITAL COSTS			$1,416,446
ANNUAL OPERATING AND MAINTENANCE				
Annual Groundwater Monitoring	1	LS	$54,600	$54,600
System Performance Monitoring				
Treatment costs	1	LS	$100,000	$100,000
Performance Monitoring	1	LS	$4,320	$4,320
	TOTAL ANNUAL COSTS			$158,920
PRESENT WORTH				
Interest Rate	8%			
Replacement Interval	30			
	TOTAL PRESENT WORTH			$1,721,407

Costs. Costs associated with Alternative S(1) include fencing. The cost of this alternative is very low relative to the other. The 30-year present worth cost, as shown in Table 4-6, is \$29,707.

The Alternative S(1) will be retained for further detailed analysis.

4.2.2.5 Alternative S(2): Landfarming. The intent of Alternative S(2) is to remove contaminants and eliminate exposure. This alternative was selected as the remedy for Sites 2, 3, and 4 soils in the FS. The major elements of this alternative include:

- Fencing
- Excavation
- Landfarming
- Grading and revegetation

Fencing would be erected at the site prior to construction to minimize exposure of the public to site contaminants prior to and during the remediation activities. Excavated soils would be hauled to a suitable landfarm for treatment. The area would be filled and graded to provide proper drainage prior to applying a final topsoil cover and seeding. In addition, the DRMO storage pad would need to be reconstructed. An evaluation of effectiveness, implementability, and cost follows:

Effectiveness. Under this scenario, human exposure at the site is unlikely. Access to the site during construction would be restricted. Public exposure to soil contaminants at the landfarm is possible. The toxicity, volume, or mobility of contaminants would be reduced or eliminated.

While chlorinated VOCs present in site soils are not readily biodegradable, these compounds are present in relatively low concentrations and would likely volatilize during the excavation, hauling, and landfarming activities.

TABLE 4-6

SITE 3
COST ESTIMATE FOR ALTERNATIVE 1: INSTITUTIONAL CONTROLS
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Item/Description	Quantity	Unit	Unit Cost	Total Cost
CAPITAL COSTS				
RESTRICTIONS				
Fencing including, mesh, posts, concrete, barbed wire and signs	700	lf	$12	$8,645
Fence gates	1	ea	$925	$925
Deed restrictions	1	LS	$10,000	$10,000
Construction Management (10%)				$1,957
	Subtotal Construction Costs (CC)			$21,527
Engineering (8% of CC)				$1,722
Permitting (10% of CC)				$2,153
Contingency (20% of CC)				$4,305
	TOTAL CAPITAL COSTS			$29,707
PRESENT WORTH				
Interest Rate	8%			
Replacement Interval	30			
	TOTAL PRESENT WORTH			$29,707

Notes: Unit costs from 1995 Means.

Implementability. The institutional and engineering controls in this alternative are implementable. The fencing is easily constructible and contractors and materials required for this alternative are readily available. A permit to landfarm would be required from both the MPCA and the township at the location of the landfarm. Additional review and permitting would be required by the Air Quality division of the MPCA due to chlorinated emissions during the landfarming process. Removal of contaminated soils from the site is not a preference of the ANGRC/MANG.

Costs. Costs associated with Alternative S(2) include construction and landfarming costs. The cost of this alternative is moderate relative to the other alternatives. The 30-year present worth cost, as shown in Table 4-7, is $679,897.

Alternative S(2) will not be retained for further detailed analysis due to the availability of other technologies at similar costs and the preference for treating soils at the base.

4.2.2.6 Alternative S(3): Incineration. The intent of Alternative S(3), similar to Alternative S(2), is to remove contaminants and eliminate exposure. The major elements of this alternative include:

- Fencing
- Excavation
- Incineration
- Grading and revegetation

Fencing would be erected at the site prior to construction to minimize exposure of the public to site contaminants prior to and during the remediation activities. Excavated soils would be treated on site by incineration.

Prior to the writing of this FS Addendum, the practice of incinerating soils with chlorinated constituents was not permitted in the State by the MPCA. More recent soil incineration technologies have added treatment in the form of a vapor emission incinerator (afterburner) prior

TABLE 4-7

SITE 3
COST ESTIMATE FOR ALTERNATIVE 2: LANDFARMING
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Item/Description	Quantity	Unit	Unit Cost	Total Cost
CAPITAL COSTS				
RESTRICTIONS				
Fencing including, mesh, posts, concrete, barbed wire and signs	700	lf	$12	$8,645
Fence gates	1	ea	$925	$925
SITE WORK				
Mobilization	1	LS	$2,000	$2,000
Clear and grub	1	acre	$2,800	$2,800
Excavation	7000	tons	$5	$37,450
Trucking to Landfarm	4400	cy	$31	$136,400
Sampling	12	ea	$400	$4,800
Backfill including compaction	4400	cy	$14	$59,576
Backfill Trucking	440	cy	$6	$2,794
Surface Restoration	1	acre	$3,500	$3,500
TREATMENT				
Landfarming	7000	tons	$27	$189,000
Construction Management (10%)				$44,789
	Subtotal Construction Costs (CC)			$492,679
Engineering (8% of CC)				$39,414
Permitting (10% of CC)				$49,268
Contingency (20% of CC)				$98,536
	TOTAL CAPITAL COSTS			$679,897
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	30			
	TOTAL PRESENT WORTH			$679,897

to air discharge. The MPCA is currently reviewing permits for soil incineration by contractors who can meet discharge, sampling, and control criteria for treating chlorinated soils.

During the final construction the area would be filled with treated soils and graded to provide proper drainage prior to applying a final topsoil cover and seeding. In addition, the DRMO storage pad would need to be reconstructed. An evaluation of effectiveness, implementability, and cost follows:

Effectiveness. Under this scenario, human exposure at the site is unlikely. Access to the site during construction would be restricted. The toxicity, volume, or mobility of contaminants would be reduced or eliminated. New soil incineration technologies provide for destruction of chlorinated VOCs in the process.

Implementability. The institutional and engineering controls in this alternative are implementable. The fencing is easily constructible and materials required for this alternative are locally available. To date, only a single contractor in the state of Minnesota is pursuing a general permit to incinerate soils containing a mixture of petroleum hydrocarbons and chlorinated compounds. A permit to incinerate soils would be required from the MPCA.

Costs. Costs associated with Alternative S(3) construction and incineration costs. The cost of this alternative is high relative to the other alternatives. The 30-year present worth cost, as shown in Table 4-8, is $1,327,567.

Alternative S(3) will be retained for further detailed analysis.

4.2.2.7 Alternative S(4): Aboveground Bioremediation. The intent of Alternative S(4), similar to Alternative S(2), is to remove contaminants and eliminate exposure. The major elements of this alternative include:

- Fencing
- Excavation
- Aboveground bioremediation
- Grading and revegetation

TABLE 4-8

SITE 3
COST ESTIMATE FOR ALTERNATIVE 3: INCINERATION
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Item/Description	Quantity	Unit	Unit Cost	Total Cost
CAPITAL COSTS				
RESTRICTIONS				
Fencing including, mesh, posts, concrete, barbed wire and signs	700	lf	$12	$8,645
Fence gates	1	ea	$925	$925
SITE WORK				
Mobilization	1	LS	$2,000	$2,000
Clear and grub	1	acre	$2,800	$2,800
Excavation	7000	tons	$5	$37,450
Trucking	4400	cy	$6	$27,060
Sampling	12	ea	$400	$4,800
Backfill including compaction	4400	cy	$14	$59,576
Backfill Trucking	440	cy	$6	$2,794
Surface Restoration	1	acre	$3,500	$3,500
TREATMENT				
Incineration	7000	tons	$100	$700,000
Mobilization/Demobilization	1	LS	$25,000	$25,000
Construction Management (10%)				$87,455
	Subtotal Construction Costs (CC)			$962,005
Engineering (8% of CC)				$76,960
Permitting (10% of CC)				$96,201
Contingency (20% of CC)				$192,401
	TOTAL CAPITAL COSTS			$1,327,567
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	30			
	TOTAL PRESENT WORTH			$1,327,567

Fencing would be erected at the site prior to construction to minimize exposure of the public to site contaminants prior to and during the remediation activities. Excavated soils would be treated on site by aboveground bioremediation.

Soil treatment would involve construction of an engineered cell for biotreating soils. This cell, as described in Section 3.5.3.2, would cover an area of approximately 21,000 square feet. Excavated soils would be shredded, mixed with nutrients, and placed in the cell. Additional bulking agents may be required for addition to the soils. Chlorinated VOCs are expected to volitalize during the remediation process and pass through the air manifold within the engineered cell. This air stream will be treated by GAC prior to discharge. While the remediation period is expected to last only a single season, the system cost is presented for a two-year operation.

During the final construction, the area would be filled with treated soils and graded to provide proper drainage prior to applying a final topsoil cover and seeding. An evaluation of effectiveness, implementability, and cost follows:

Effectiveness. Under this scenario, human exposure at the base is unlikely. Access to the site during construction would be restricted. The toxicity, volume, or mobility of contaminants would be reduced or eliminated. Spent carbon used for treating air from the soil treatment cell would require regeneration at a carbon recycler. Contaminants adsorbed to carbon would be thermally destroyed.

Implementability. The institutional and engineering controls in this alternative are implementable. The fencing is easily constructable and contractors and materials required for this alternative are readily available.

Costs. Costs associated with Alternative S(4) include construction and operation costs. The cost of this alternative is moderate relative to the other alternatives. The present worth cost for the two year expected life of the system is $637,476, as shown in Table 4-9.

Alternative S(4) will be retained for further detailed analysis.

TABLE 4-9

SITE 3
COST ESTIMATE FOR ALTERNATIVE 4: ABOVEGROUND BIOREMEDIATION
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Item/Description	Quantity	Unit	Unit Cost	Total Cost
CAPITAL COSTS				
RESTRICTIONS				
Fencing including, mesh, posts, concrete, barbed wire and signs	700	lf	$12	$8,645
Fence gates	1	ea	$925	$925
SITE WORK				
Mobilization	1	LS	$2,000	$2,000
Clear and grub	1	acre	$2,800	$2,800
Excavation	7000	tons	$5	$37,450
Trucking	4400	cy	$6	$27,060
Sampling	12	ea	$400	$4,800
Backfill including compaction	4400	cy	$14	$59,576
Backfill Trucking	440	cy	$6	$2,794
Surface Restoration	1	acre	$3,500	$3,500
TREATMENT				
Bioremediation [1]	7,000	tons	$20	$140,000
Jersey Barriers	96	ea	$33	$3,120
Vapor Piping (Polyethylene)	4,200	lf	$4	$15,414
Sprinkler piping (PVC)	3,067	lf	$3	$9,262
Submersible pump	1	ea	$200	$200
Liner [2]	25,000	sf	$0	$3,750
Liner Installation [2]	2	day	$750	$1,500
Blower [3]	1	ea	$3,600	$3,600
Off-gas Treatment (GAC) [4]	1	LS	$25,000	$25,000
Initial Soil Sampling	8	ea	$1,000	$8,000
Final Soil Sampling	8	ea	$1,000	$8,000
Start-up Respiration Test	1	ea	$17,280	$17,280
Electricity	16,107	Kw-hr	$0.20	$3,221
Construction Management (10%)				$38,790
	Subtotal Construction Costs (CC)			$426,688

TABLE 4-9

SITE 3
COST ESTIMATE FOR ALTERNATIVE 4: ABOVEGROUND BIOREMEDIATION
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM
(Continued)

Item/Description	Quantity	Unit	Unit Cost	Total Cost
Engineering (8% of CC)				$34,135
Permitting (10% of CC)				$42,669
Contingency (20% of CC)				$85,338
	TOTAL CAPITAL COSTS			$588,829
ANNUAL OPERATING AND MAINTENANCE				
Respiration Tests	1	LS	$17,280	$17,280
Annual GAC Costs	1	LS	$10,000	$10,000
	TOTAL ANNUAL O&M COSTS			$27,280
PRESENT WORTH				
Interest Rate	8%			
Replacement Interval	2			
	TOTAL PRESENT WORTH			$637,476

Notes: Unit Costs for materials from Means 1995 except where noted
1: Bioremediation cost from literature
2: Liner costs from vendor quote - Gundle
3: Blower costs from vendor quote - Pearson Technologies
4: GAC costs from vendor quote - Weststates

4.2.3 Site 4

Site 4 groundwater has historically contained detections of VOCs and TPH. According to the previous FS, these detections were considered low level and remedial alternatives for site groundwater were not developed. To monitor the water quality, a groundwater monitoring

program is on-going at the site. Based on the low levels of constituents detected in groundwater, a single no-action alternative is presented for groundwater. This alternative provides for groundwater monitoring and five-year site reviews.

Site 4 contains contaminated sediments within the perimeter ditch and shallow soils from "hot spots" located throughout the site. In addition, Site 4 contains an assumed volume of contaminated soils from within the bermed area surrounding the fuel storage tanks. Groundwater contaminant levels are all below action limits. Alternatives developed for Site 4 were based on the assumption that soil and sediment treatment will meet ARARs. Given the cleanup objectives for Site 4, only benzene, total BTEX, and TPH are compounds identified in site soils and sediments as exceeding ARARs. Four alternatives for Site 4 soil and sediment, S(1) Institutional Controls, S(2) Landfarming, S(3) Incineration, and S(4) Aboveground Bioremediation are presented in this section.

4.2.3.1 Alternative GW(1): No Action. The only elements included in the no action alternative are:

- Groundwater monitoring
- Site review

The no-action alternative is used as a baseline for comparison with other alternatives. Under this alternative, no work to reduce the exposure of contaminants to populations or protect the environment from degradation would be undertaken. Since contaminants would remain in the area of concern, the site would require reviews to ensure that a direct exposure to populations was not occurring. An evaluation of effectiveness, implementability, and cost follows:

Effectiveness. Under this scenario, human exposure to site groundwater contaminants is unlikely. Potable water for the Airport is supplied by the city. The toxicity, mobility, or volume of groundwater contaminants would not be reduced.

Implementability. A no-action alternative is easily implemented. Long-term management, reviews, and groundwater monitoring would be required due to contaminated materials left in place.

Costs. Costs associated with the no-action alternative would include groundwater monitoring and reviews. The cost of this alternative is low relative to the other alternatives. The present worth cost of one year of groundwater monitoring is $133,438, as shown in Table 4-10.

The no-action alternative will be retained for further detailed analysis.

TABLE 4-10

SITE 4
COST ESTIMATE FOR ALTERNATIVE 1: GROUNDWATER MONITORING
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Item/Description	Quantity	Unit	Unit Cost	Total Cost
CAPITAL COSTS				
SAMPLING				
Groundwater Sampling and Analytical	4	round	$13,650	$54,600
Construction Management (10%)				$5,460
	Subtotal Construction Costs (CC)			$60,060
Engineering (8% of CC)				$4,805
Permitting (10% of CC)				$6,006
Contingency (20% of CC)				$12,012
	TOTAL CAPITAL COSTS			$82,883
ANNUAL OPERATING AND MAINTENANCE				
Groundwater Sampling and Analytical	4	round	$13,650	$54,600
PRESENT WORTH				
Interest Rate	8%			
Replacement Interval	1			
	TOTAL PRESENT WORTH			$133,438

4.2.3.2 Alternative S(1): Institutional Controls

Alternative S(1) provides for better protection to the public from exposure to area contaminants than a no-action alternative. The major elements of this alternative include:

- Fencing

Fencing around the site would provide an institutional control limiting access to the site. Currently fencing installed around Site 4 would require upgrading to meet USEPA guidance and sufficiently secure the site from public entry. An evaluation of effectiveness, implementability, and cost follows:

Effectiveness. Under this scenario human exposure would be limited. The toxicity, mobility, or volume of contaminants would not be reduced. Soil and sediment contamination may continue to leach chemicals into the groundwater or surface water.

Implementability. This alternative is easily implementable. This alternative would require long-term management due to contaminated materials left in place.

Costs. Costs associated with Alternative S(1) include fencing. The cost of this alternative is very low relative to the other. The 30-year present worth cost, as shown in Table 4-11, is $30,878.

The Alternative S(1) will be retained for further detailed analysis.

4.2.3.3 Alternative S(2): Landfarming. The intent of Alternative S(2) is to remove contaminants and eliminate exposure. The major elements of this alternative include:

- Excavation
- Landfarming
- Grading and revegetation

TABLE 4-11

SITE 4
COST ESTIMATE FOR ALTERNATIVE 1: INSTITUTIONAL CONTROLS
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Item/Description	Quantity	Unit	Unit Cost	Total Cost
CAPITAL COSTS				
RESTRICTIONS				
Fencing including mesh, posts, concrete, barbed wire, and signs	1,625	lf	$12	$19,500
Fence gates	1	ea	$925	$925
Construction Management (10%)				$1,950
	Subtotal Construction Costs (CC)			$22,375
Engineering (8% of CC)				$1,790
Permitting (10% of CC)				$2,238
Contingency (20% of CC)				$4,475
	TOTAL CAPITAL COSTS			$30,878
PRESENT WORTH				
Interest Rate	8%			
Replacement Interval	30			
	TOTAL PRESENT WORTH			$30,878

Unlike Site 3, excavation of Site 4 contaminated soils would be accomplished relatively quickly due to the shallow depth of soil impacts. For this reason fencing is not included as part of this alternative since deep excavations will not be left open for long periods of time. Excavated soils and sediments would be hauled to a suitable landfarm for treatment. Dredged ditches would require some regrading and revegetation. An evaluation of effectiveness, implementability, and cost follows:

Effectiveness. Under this scenario, human exposure at the site is unlikely. Access to the site during construction would be restricted with the current perimeter fence. Public exposure to soil contaminants at the landfarm is possible. The toxicity, volume, or mobility of contaminants would be reduced or eliminated.

Implementability. The institutional and engineering controls in this alternative are implementable. Contractors and materials required for this alternative are readily available. A permit to landfarm would be required from both the MPCA and the township at the location of the landfarm. Removal of contaminated soils from the base is not a preference of the ANGRC/MANG.

Costs. Costs associated with Alternative S(2) include construction and landfarming costs. The cost of this alternative is moderate relative to the other alternatives. The 30-year present worth cost, as shown in Table 4-12, is $727,900.

Alternative S(2) will not be retained for further detailed analysis due to the availability of other technologies at similar costs and the preference for treating soils at the base.

4.2.3.4 Alternative S(3): Incineration. The intent of Alternative S(3) is similar to Alternative S(2) and is to remove contaminants and eliminate exposure. The major elements of this alternative include:

- Excavation
- Incineration
- Grading and revegetation

Like Alternative S(2), fencing would not be required at Site 4 due to the short period required for excavation of soils. In Alternative S(3), excavated soils would be treated on site by incineration. These soils would likely be incorporated into Site 3 soils if incineration is the preferred remedy. Dredged ditches would require some regrading and revegetation during the final construction. An evaluation of effectiveness, implementability, and cost follows:

TABLE 4-12

SITE 4
COST ESTIMATE FOR ALTERNATIVE 2: LANDFARMING
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Item/Description	Quantity	Unit	Unit Cost	Total Cost
CAPITAL COSTS				
SITE WORK				
Mobilization	1	LS	$2,000	$2,000
Clear and grub	0.2	acre	$2,800	$560
Excavation	7330	tons	$5	$39,216
Trucking to Landfarm	4581	cy	$31	$142,011
Sampling	15	ea	$400	$6,000
Backfill including compaction	4581	cy	$14	$62,027
Backfill Trucking	4581	cy	$6	$29,089
Surface Restoration	0.2	acre	$3,500	$700
TREATMENT				
Landfarming	7330	tons	$27	$197,910
Construction Management (10%)				$47,951
	Subtotal Construction Costs (CC)			$527,464
Engineering (8% of CC)				$42,197
Permitting (10% of CC)				$52,746
Contingency (20% of CC)				$105,493
	TOTAL CAPITAL COSTS			$727,900
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	30			
	TOTAL PRESENT WORTH			$727,900

Effectiveness. Under this scenario, human exposure at the base is unlikely. Access to the site during construction would be restricted. The toxicity, volume, or mobility of contaminants would be reduced or eliminated.

Implementability. The engineering controls in this alternative are implementable. Contractors and materials required for this alternative are readily available. A permit to incinerate soils would be required from the MPCA.

Costs. Costs associated with Alternative S(3) include construction and incineration costs. The cost of this alternative is high relative to the other alternatives. The 30-year present worth cost, as shown in Table 4-13, is $998,013.

Alternative S(3) will be retained for further detailed analysis.

4.2.3.5 Alternative S(4): Aboveground Bioremediation. The intent of Alternative S(4), similar to Alternative S(2), is to remove contaminants and eliminate exposure. The major elements of this alternative include:

- Excavation
- Aboveground bioremediation
- Grading and revegetation

Like Alternative S(2), fencing would not be required at Site 4 due to the short period required for excavation of soils. Excavated soils would be treated on site by aboveground bioremediation. Soil treatment would involve construction of an engineered cell for biotreating soils. This cell as described in Section 3, would cover an area of approximately 39,000 square feet. If soils from Site 3 are treated using aboveground bioremediation, Sites 3 and 4 soils could easily be incorporated into one engineered treatment cell. Excavated soils would be shredded, mixed with nutrients, and placed in the cell. Additional bulking agents may be required for addition to the soils. While the remediation period is expected to last only a single season, the system cost is presented for a two-year operation.

TABLE 4-13

SITE 4
COST ESTIMATE FOR ALTERNATIVE 3: INCINERATION
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Item/Description	Quantity	Unit	Unit Cost	Total Cost
CAPITAL COSTS				
SITE WORK				
Mobilization	1	LS	$2,000	$2,000
Clear and grub	0.2	acre	$2,800	$560
Excavation	7330	tons	$5	$39,216
Trucking	4581	cy	$6	$28,173
Sampling	15	ea	$400	$6,000
Backfill including compaction	4581	cy	$14	$62,027
Backfill Trucking	4581	cy	$6	$29,089
Surface Restoration	0.2	acre	$3,500	$700
TREATMENT				
Incineration	4581	tons	$100	$458,100
Mobilization/Demobilization	1	LS	$25,000	$25,000
Construction Management (10%)				$65,086
	Subtotal Construction Costs (CC)			$715,951
Engineering (8% of CC)				$57,276
Permitting (10% of CC)				$71,595
Contingency (20% of CC)				$143,190
	TOTAL CAPITAL COSTS			$988,013
PRESENT WORTH				
Interest Rate	7%			
Replacement Interval	30			
	TOTAL PRESENT WORTH			$988,013

Dredged ditches would require some regrading and revegetation during the final construction. An evaluation of effectiveness, implementability, and cost follows:

Effectiveness. Under this scenario, human exposure at the base is unlikely. Access to the site during construction would be restricted. The toxicity, volume, or mobility of contaminants would be reduced or eliminated.

Implementability. The engineering controls in this alternative are implementable. Contractors and materials required for this alternative are readily available.

Costs. Costs associated with Alternative S(4) include construction and operation costs. The cost of this alternative is moderate relative to the other alternatives. The present worth cost based on an expected two year life of the system is $555,692, as shown in Table 4-14.

Alternative S(4) will be retained for further detailed analysis.

TABLE 4-14

SITE 4
COST ESTIMATE FOR ALTERNATIVE 4: ABOVEGROUND BIOREMEDIATION
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY

Item/Description	Quantity	Unit	Unit Cost	Total Cost
CAPITAL COSTS				
SITE WORK				
Mobilization	1	LS	$2,000	$2,000
Clear and grub	0.2	acre	$2,800	$560
Excavation	7330	tons	$5	$39,216
Trucking	4581	cy	$6	$28,173
Sampling	15	ea	$400	$6,000
Backfill including compaction	4581	cy	$14	$62,027
Backfill Trucking	4581	cy	$6	$29,089
Surface Restoration	0.2	acre	$3,500	$700
TREATMENT				
Bioremediation [1]	4581	tons	$20	$91,620
Jersey Barriers	136	ea	$33	$4,420
Vapor Piping (Polyethylene)	8250	lf	$4	$30,278
Sprinkler piping (PVC)	4250	lf	$3	$12,835
Submersible pump	1	ea	$200	$200
Liner [2]	4400	sf	$0.15	$660
Liner Installation [2]	1	day	$750	$750
Blower [3]	1	ea	$3,600	$3,600
Off-gas Treatment (GAC) [4]	1	ls	$1,250	$1,250
Initial Soil Sampling	8	ea	$1,000	$8,000
Final Soil Sampling	8	ea	$1,000	$8,000
Start-up Respiration Test	1	ea	$15,120	$15,120
Electricity	16,107.12	Kw-hr	$0.20	$3,221
Construction Management (10%)				$34,772
	Subtotal Construction Costs (CC)			$382,491
Engineering (8% of CC)				$30,599
Permitting (10% of CC)				$38,249
Contingency (20% of CC)				$76,498
	TOTAL CAPITAL COSTS			$527,837
ANNUAL OPERATING AND MAINTENANCE				
Respiration Tests	1	LS	$15,120	$15,120
Annual GAC Costs	1	LS	$500	$500
	TOTAL ANNUAL O&M COSTS			$15,620

TABLE 4-14

SITE 4
COST ESTIMATE FOR ALTERNATIVE 4: ABOVEGROUND BIOREMEDIATION
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY
(Continued)

Item/Description	Quantity	Unit	Unit Cost	Total Cost
PRESENT WORTH				
Interest Rate	8%			
Replacement Interval	2			
	TOTAL PRESENT WORTH			$555,692

Notes: Unit Costs for materials from Means 1995 except where noted.
1: Bioremediation cost from literature.
2: Liner costs from vendor quote - Gundle
3: Blower costs from vendor quote - Pearson Technologies.
4: GAC costs from vendor quote - Carbonair.

SECTION 5.0

DETAILED ANALYSIS OF ALTERNATIVES

In this section selected alternatives initially screened in Section 4 are analyzed in detail in order to provide decision makers with sufficient information to select a single remedy. For this FS Addendum, alternatives are evaluated upon requirements established by CERCLA. To meet these requirements the remedy must:

- Be protective of human health and the environment
- Attain ARARs (or provide a basis for invoking a waiver)
- Be cost effective
- Be a permanent solution that uses alternative treatment technologies or resource-recovery technologies to the maximum extent possible
- Show a preference for treatment that reduces toxicity, mobility, or volume as a principal element

In addition, CERCLA emphasizes the long-term effectiveness of the remedy including:

- The long-term uncertainties associated with land disposal
- The goals, objectives, and requirements of the Solid Waste Disposal Act
- The persistence, toxicity, and mobility of hazardous substances and their constituents, and their propensity to bioaccumulate
- Short- and long-term potential for adverse health effects from human exposure to contaminants

- Long-term maintenance costs

- The potential for future remedial action costs if the alternative remedial action in question were to fail

- The potential threat to human health and the environment associated with excavation, transportation, and disposal, or containment

From the initial screening on the basis of effectiveness, implementability, and cost, the following alternatives were carried forward from Section 4 for detailed analysis:

Site 2

Alternative	**Action**
GW(1)	No Action

Site 3

Alternative	**Action**
Groundwater	
GW(1)	No Action
GW(2)	French Drain
GW(3)	MERD
Soils	
S(1)	Institutional Controls
S(3)	Incineration
S(4)	Aboveground Bioremediation

Site 4

Alternative	**Action**
Groundwater	
GW(1)	No Action

Soils

S(1)	Institutional Controls
S(3)	Incineration
S(4)	Aboveground Bioremediation

Alternatives for groundwater and soils at Sites 3 and 4 will be evaluated separately. One alternative from each of the soil and groundwater alternatives will be selected as part of the final remedy for Sites 3 and 4.

Each of these alternatives will be evaluated by the nine separate criteria intended to meet CERCLA requirements and intentions. These criteria are presented in the following section.

5.1 ANALYSIS CRITERIA

In this section, a detailed analysis of each alternative is conducted using the following nine criteria as directed by CERCLA: short-term effectiveness; long-term effectiveness; implementability; cost; reduction of toxicity, mobility, or volume; compliance with ARARs; overall protection of human health and the environment; state acceptance; and community acceptance. These criteria are explained in detail in the following paragraphs.

Short-term Effectiveness. An evaluation of the effectiveness of alternatives in protecting human health and the environment during the construction and implementation of a remedy until the response objectives are met are included in the analysis.

Long-term Effectiveness. Long-term effectiveness is evaluated with respect to the permanence of the alternative, the magnitude of residual risk, and the adequacy and reliability of controls used to manage remaining waste over the long term.

Overall Protection of Human Health and Environment. The analysis includes an evaluation of how each alternative reduces the risk from potential exposure pathways through treatment, engineering, and/or institutional controls. An examination of whether alternatives pose any acceptable short-term or cross-media impacts is also included.

Implementability. Each alternative is ··· uated for the technical and administrative feasibility of the alternative and the availability of the · ods and services needed to implement it.

Cost. The costs estimated for the FS are order-of-magnitude level estimated. These costs, as presented in Section 4, consider the capital, indirect, operation, and maintenance costs on a present-worth basis.

Reduction of Mobility, Toxicity, or Volume. Remedial alternatives are evaluated against the anticipated performance of the proposed treatment technologies.

Compliance with ARARs. The ability of each alternative to meet all its federal and state requirements that are applicable or relevant and appropriate, or the need to justify a waiver is noted for each alternative.

State Acceptance. This criterion reflects the state's apparent preferences among or concerns about each alternative. State acceptance will be determined after review of this FS by MPCA.

Community Acceptance. This criterion reflects the community's apparent preferences among or concerns about each alternative. As community involvement has yet to be solicited in the evaluation of alternatives, community acceptance of alternatives will be determined at a later date

5.2 SITE 2

The alternative for Site 2 groundwater is presented below. The results of the analysis of this alternative is summarized in Table 5-1.

TABLE 5-1

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES FOR SITE 2
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Criteria	Alternative GW(1): No Action
Effectiveness	
Short-term:	Likelihood of exposure is low.
Long-term:	
Does the alternative meet the definition of a permanent remedy?	No. However, natural attenuation of groundwater will likely reduce contaminants below cleanup goals.
How does the treatment employed address principal threats?	No treatment is employed. Natural attenuation reduces the possibility of human exposure to groundwater contaminants. Contaminant migration to environmental receptors would be reduced over time.
To what extent are the effects of treatment irreversible?	Degradation of contaminants is not reversible.
Overall Protection of Human Health and the Environment	
What is the magnitude of the health and ecological risks associated with the residuals that will remain?	Low. There are no known exposure pathways.
Implementability	
Technical Feasibility:	Monitoring and reviews are feasible.
How reliably does the technology meet RAOs and cleanup levels?	Unknown. The rate of natural attenuation is not known at this time.
Administrative Feasibility:	
What type/degree of long-term management is required?	Some institutional management is required due to contaminants left in place and administration of the monitoring program.

TABLE 5-1

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES FOR SITE 2
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM
(Continued)

Criteria	Alternative GW(1): No Action
Availability of Services and Materials:	
Is the technology generally available and sufficiently demonstrated?	Yes.
Reduction of Toxicity, Mobility, or Volume	
What percent of the contaminated material is destroyed/contained?	Unknown. The rate of natural attenuation is not known at this time.
What residuals remain?	Cis-1,2-dichloroethene is currently above cleanup goals.
What are the uncertainties associated w/land disposal residuals/untreated wastes?	None.
Compliance with ARARs[b]	
Chemical Specific:	Cis-1,2-dichloroethene is currently above cleanup goals.
Location Specific:	None.
Action Specific:	None.
State and Community Acceptance	To be reviewed.
Cost[a]	$62,320

a Present worth cost is calculated based on a 8% discount rate over a specified term (see Section 4)
b Applicable or relevant and appropriate requirement

5.2.1 Alternative GW(1): No Action

The no-action alternative for Site 2 groundwater consists of groundwater monitoring and site reviews. No other work to reduce exposure to groundwater contaminants or protect the environment from further degradation would be taken. An assessment of Alternative GW(1) follows:

Short-term Effectiveness. The likelihood of human exposure to site groundwater is very low. Currently, there are no known exposure pathways.

Long-term Effectiveness. Similar to effectiveness on a short term, this alternative is likely to be effective over the long term. Site closure is expected after developing a baseline of groundwater monitoring results that verify current natural attenuation of the groundwater contaminants.

Overall Protection of Human Health and the Environment. This alternative is moderately effective in preventing exposure of human and environmental receptors to area contaminants by providing groundwater sampling results for further decision making.

Implementability

Technical Feasibility. The groundwater monitoring and reviews for this alternative are easily implementable.

Administrative Feasibility. Some institutional management would be required for this alternative because contaminated materials would remain on site.

Availability of Services and Materials. No construction materials or construction services would be required to implement this alternative.

Cost. The no-action alternative cost is considered low. The total present-worth cost for this alternative is $63,320.

Reduction of Toxicity, Mobility, or Volume. The no-action alternative would not result in the reduction of toxicity, mobility, or volume of contaminants. However, contaminants on site have been shown to be attenuating naturally.

Compliance with ARARs. Through natural attenuation, the no-action alternative is expected to eventually meet the State HRLs. No location- or action-specific ARARs have been identified for this alternative.

State Acceptance. State acceptance will be determined after review of this FS by MPCA.

Community Acceptance. Community acceptance will be determined after a review of this alternative by the community.

5.3 SITE 3 GROUNDWATER

All alternatives for Site 3 groundwater are presented below. The results of the analysis of these alternatives is summarized in Table 5-2.

5.3.1 Alternative GW(1): No Action

The no-action alternative for Site 3 groundwater consists of groundwater monitoring and site reviews. No other work to reduce exposure to groundwater contaminants or protect the environment from further degradation would be taken. An assessment of Alternative GW(1) follows:

Short-term Effectiveness. The likelihood of human exposure to site groundwater is low. Construction activities at the Airport such as water well drilling are controlled. It is unlikely that conditions will lead to exposure pathways in the short term.

TABLE 5-2

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES FOR SITE 3 GROUNDWATER
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Criteria	Alternative		
	GW(1): No Action	**GW(2): French Drain**	**GW(3): MERD**
Effectiveness Short-term:	Likelihood of exposure is low.	Likelihood of exposure is low.	Likelihood of exposure is low.
Long-term: Does the alternative meet the definition of a permanent remedy?	No. No RAOs or cleanup objectives will be met by this alternative.	Containment would be met by this alternative. Contaminants may be reduced below cleanup levels over time.	Containment would be met by this alternative. Contaminants may be reduced below cleanup levels over time.
How does the treatment employed address principal threats?	No treatment is employed. No protection is employed to reduce risk.	Containment prevents migration of contaminants to potable water sources.	Containment prevents migration of contaminants to potable water sources.
To what extent are the effects of treatment irreversible?	No treatment applied.	Contaminants are permanently removed.	Contaminants are permanently removed.
Overall Protection of Human Health and the Environment What is the magnitude of the health and ecological risks associated with the residuals that will remain?	High. No protection is employed to reduce risk.	Low. Containment of groundwater and drilling restrictions protect public health and environmental receptors.	Low. Containment of groundwater and drilling restrictions protect public health and environmental receptors.
Implementability Technical Feasibility:	Monitoring and reviews are feasible.	Construction and monitoring is feasible.	Construction is feasible although funnel and gate is a patented technology.
How reliably does the technology meet RAOs and cleanup levels?	This alternative will unlikely meet RAOs or cleanup levels.	This alternative meets RAOs.	This alternative meets RAOs.
Administrative Feasibility: What type/degree of long-term management is required?	Long-term institutional management is required due to contaminants left in place and administration of the monitoring program.	Long-term institutional management is required due to the persistence of contaminants.	Long-term institutional management is required due to the persistence of contaminants.

TABLE 5-2

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES FOR SITE 3 GROUNDWATER
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM
(Continued)

Criteria	Alternative		
	GW(1): No Action	GW(2): French Drain	GW(3): MERD
Availability of Services and Materials:			
Is the technology generally available and sufficiently demonstrated?	Yes.	Yes.	MERD technology is considered experimental. Very little experience exists with this technology.
Reduction of Toxicity, Mobility, or Volume			
What percent of the contaminated material is destroyed/contained?	Only slight natural attenuation is expected.	The rate of contaminant removal is unknown.	The rate of contaminant removal is unknown.
What residuals remain?	VOCs and chlorinated compounds.	VOCs and chlorinated compounds.	VOCs and chlorinated compounds.
What are the uncertainties associated w/land disposal residuals/untreated wastes?	None.	GAC units would require off-site regulation.	Possible incomplete reaction would leave daughter products (vinyl chloride).
Compliance with ARARs[b]			
Chemical Specific:	Will not meet cleanup objectives.	Will only meet cleanup objective in the long-term.	Will only meet cleanup objective in the long-term.
Location Specific:	None.	Construction permits required.	Construction permits required.
Action Specific:	None.	POTW permits required.	None.
State and Community Acceptance	To be reviewed.	To be reviewed.	To be reviewed.
Cost[a]	$133,438	$1,004,130	$1,721,407

a Present worth cost is calculated based on a 8% discount rate over a specified term (see Section 4)
b Applicable or relevant and appropriate requirement

Long-term Effectiveness. This alternative is ineffective over the long term. No remedial action objectives as presented in Section 3 would be met by the no-action alternative. Groundwater monitoring would provide the information necessary to enact appropriate corrective actions in the future.

Overall Protection of Human Health and the Environment. Similar to short- and long-term effectiveness, this alternative provides negligible protection.

Implementability

Technical Feasibility. The groundwater monitoring and site reviews required for this alternative are easily implementable.

Administrative Feasibility. Considerable long-term institutional management would be associated with this alternative because contaminated groundwater would remain on site. Indefinite management of the groundwater monitoring program would be required.

Availability of Services and Materials. No construction materials or services would be required to implement this alternative.

Cost. The no-action alternative cost is the least of all alternatives considered. The total present-worth cost for this alternative is $133,438.

Reduction of Toxicity, Mobility, or Volume. The no-action alternative would not result in the reduction of toxicity, mobility, or volume of contaminants.

Compliance with ARARs. The no-action alternative will not meet the State HRLs. No location- or action-specific ARARs have been identified for this alternative.

State Acceptance. State acceptance will be determined after review of FS by MPCA.

Community Acceptance. Community acceptance will be determined after a review of this alternative by the community.

5.3.2 Alternative GW(2): French Drain

Alternative GW(2) consists of enacting drilling restrictions, groundwater monitoring, constructing a French drain, and operating a groundwater treatment system. Extracted groundwater would be treated with a GAC system. An assessment of Alternative GW(2) follows:

Short-term Effectiveness. The likelihood of human exposure to site groundwater is low. Construction activities at the Airport such as water well drilling are controlled. It is unlikely that conditions will lead to exposure pathways in the short term.

Long-term Effectiveness. This alternative would be effective in providing long-term management required to prevent human exposure to groundwater contaminants and engineering controls to reduce the groundwater contaminant plume. The remedial action objective of providing gradient controls and use restrictions as presented in Section 3 would be met by this alternative

Overall Protection of Human Health and the Environment. This alternative is effective in preventing exposure of human population to contaminants in groundwater. Contaminant migration to environmental receptors would be reduced over time.

Implementability

Technical Feasibility. All site activities planned under this alternative are technically feasible.

Administrative Feasibility. Long-term institutional management would be associated with this alternative because of the persistence of contaminants in groundwater

Availability of Services and Materials. Construction materials and contracting services are readily available.

Cost. The cost of Alternative GW(2) is moderate relative to the other alternatives considered. The total present-worth cost for this alternative is $1,004,130.

Reduction of Toxicity, Mobility, or Volume. Alternative GW(2) would result in the reduction of mobility, toxicity, or volume of contaminants.

Compliance with ARARs. Remedial objectives for Alternative GW(2) are to meet State HRL cleanup criteria. Due to the unknowns with contaminant plume magnitude and extent along with unknowns concerning physical constraints, the success of the alternative in meeting chemical-specific ARARs is also unknown. No location-specific alternatives are identified. Action-specific-ARARs would include all required POTW permits.

State Acceptance. State acceptance will be determined after review of this FS by MPCA.

Community Acceptance. Community acceptance will be determined after a review of this alternative by the community.

5.3.3 Alternative GW(3): MERD

Alternative GW(3) consists of enacting drilling restrictions, groundwater monitoring, and constructing a funnel and gate containment system with a MERD reaction cell. An assessment of Alternative GW(3) follows:

Short-term Effectiveness. The likelihood of human exposure to site groundwater is low. Construction activities at the Airport such as water well drilling are controlled. It is unlikely that conditions will lead to exposure pathways in the short term.

Long-term Effectiveness. This alternative would be effective in providing long-term management required to prevent human exposure to groundwater contaminants and engineering controls to reduce the groundwater contaminant plume. The remedial-action objective of providing gradient controls and use restrictions as presented in Section 3 would be met by this alternative

Overall Protection of Human Health and the Environment. This alternative is effective in preventing exposure of human population to contaminants in groundwater. Contaminant migration to environmental receptors would be reduced over time.

Implementability

Technical Feasibility. Extensive bench and pilot testing is required to determine the feasibility of applying both funnel and gate technology and MERD technology to the site. Implementation of MERD on other sites has been very limited.

Administrative Feasibility. Long-term institutional management would be associated with this alternative because of the persistence of contaminants in groundwater

Availability of Services and Materials. Construction materials and contracting services are available. Sealed sheet piling used in the construction of the funnel and gate is a patented product and would require obtaining rights prior to using this technology.

Cost. The cost of Alternative GW(3) is high relative to the other alternatives considered. The total present-worth cost for this alternative is $1,721,407.

Reduction of Toxicity, Mobility, or Volume. Alternative GW(3) would result in the reduction of mobility, toxicity, or volume of contaminants.

Compliance with ARARs. Remedial objectives for Alternative GW(3) are to meet State HRL cleanup criteria. Due to the unknowns with contaminant plume magnitude and extent along with unknowns concerning physical constraints, the success of the alternative in meeting chemical-specific ARARs is also unknown. Location-specific ARARs may include zoning ordinances and deed restrictions. Action specific-ARARs would include all required construction permits.

State Acceptance. State acceptance will be determined after review of this FS by MPCA.

Community Acceptance. Community acceptance will be determined after a review of this alternative by the community.

5.4 SITE 3 SOIL

All alternatives for Site 3 soil are presented below. The results of the analysis of these alternatives are summarized in Table 5-3.

5.4.1 Alternative S(1): Institutional Controls

Alternative S(1) consists of constructing a perimeter fence around the site to limit access. An assessment of Alternative S(1) follows:

Short-term Effectiveness. The perimeter fence in this alternative would be effective in reducing the likelihood of exposure to trespassers.

Long-term Effectiveness. The remedial-action objective of reducing exposure to area contaminants as presented in Section 3 would be met by this alternative. However, this alternative does not reduce or remove the contaminant source to groundwater and would require long-term management for the site.

Overall Protection of Human Health and the Environment. This alternative is moderately effective in preventing exposure of human population to contaminants in soil and sediment. Further degradation of groundwater would continue as contaminants leach from soil and sediment.

Implementability

Technical Feasibility. All site activities planned under this alternative are technically feasible.

Administrative Feasibility. Considerable long-term institutional management would be associated with this alternative because contaminated materials would remain on site.

TABLE 5-3

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES FOR SITE 3 SOIL
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

	Alternative		
Criteria	**S(1): Institutional Controls**	**S(3): Incineration**	**S(4): Aboveground Bioremediation**
Effectiveness			
Short-term:	Perimeter fence is effective in reducing contact.	Perimeter fence is effective in reducing contact.	Perimeter fence is effective in reducing contact.
Long-term:			
Does the alternative meet the definition of a permanent remedy?	No. Fencing alone is insufficient in eliminating health risks or preventing continued degradation.	Yes. Soil contaminants in excavated soils are destructed.	Yes. Soil contaminants in excavated soils are destructed.
How does the treatment employed address principal threats?	No treatment is employed. Limited protection is employed to reduce risk.	Soils excavated and treated will not pose a future risk through ingestion or leach contaminants to groundwater.	Soils excavated and treated will not pose a future risk through ingestion or leach contaminants to groundwater.
To what extent are the effects of treatment irreversible?	No treatment applied.	Contaminants are permanently removed.	Contaminants are permanently removed.
Overall Protection of Human Health and the Environment			
What is the magnitude of the health and ecological risks associated with the residuals that will remain?	High. No protection is employed to reduce risk.	Low. Contaminants will be reduced or eliminated in treated soil.	Low. Contaminants will be reduced or eliminated in treated soil.
Implementability			
Technical Feasibility:	No further work required.	Construction is feasible.	Construction is feasible.
How reliably does the technology meet RAOs and cleanup levels?	This alternative will unlikely meet RAOs or cleanup levels.	This alternative meets RAOs and cleanup goals.	This alternative meets RAOs and cleanup goals.
Administrative Feasibility:			
What type/degree of long-term management is required?	Long-term institutional management is required due to contaminants left in place.	No long-term management is required.	No long-term management is required.
Availability of Services and Materials:			
Is the technology generally available and sufficiently demonstrated?	Yes.	Yes.	Yes.

TABLE 5-3

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES FOR SITE 3 SOIL
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM
(Continued)

Criteria	Alternative		
	S(1): Institutional Controls	S(3): Incineration	S(4): Aboveground Bioremediation
Reduction of Toxicity, Mobility, or Volume			
What percent of the contaminated material is destroyed/contained?	No reduction in TMV is expected.	All excavated soils will be treated to cleanup goals.	All excavated soils will be treated to cleanup goals.
What residuals remain?	VOCs and chlorinated compounds.	None.	None.
What are the uncertainties associated w/land disposal residuals/untreated wastes?	None.	None.	GAC units would require off-site generation.
Compliance with ARARs[b]			
Chemical Specific:	Will not meet cleanup objectives.	Will meet cleanup objectives.	Will meet cleanup objectives.
Location Specific:	None.	None.	None.
Action Specific:	Construction permits.	Permit to incinerate soils required.Construction permits	Approval by MPCA. Construction permits.
State and Community Acceptance	To be reviewed.	To be reviewed.	To be reviewed.
Cost[a]	$29,707	$1,327,567	$637,476

a Present worth cost is calculated based on a 8% discount rate over a specified term (see Section 4)

b Applicable or relevant and appropriate requirement

Availability of Services and Materials. Construction materials and contracting services are available.

Cost. The cost of Alternative S(1) is low relative to the other alternatives considered. The total present-worth cost for this alternative is $29,707.

Reduction of Toxicity, Mobility, or Volume. Alternative S(1) would not result in the reduction of toxicity or volume of contaminants.

Compliance with ARARs. Alternative S(1) will not meet the MPCA leaching based cleanup goals. Action-specific ARARs would include all required construction permits.

State Acceptance. State acceptance will be determined after review of this FS by MPCA.

Community Acceptance. Community acceptance will be determined after a review of this alternative by the community.

5.4.2 Alternative S(3): Incineration

Alternative S(3) consists of securing the site with a perimeter fence, excavating contaminated soils, treating soils by incineration, and restoring the site by grading and revegetating. An assessment of Alternative S(3) follows:

Short-term Effectiveness. The perimeter fence in this alternative would be effective in reducing the likelihood of exposure to trespassers during the construction interim.

Long-term Effectiveness. This alternative is effective over the long term in preventing human exposure to contaminants in area sediment and soil. The remedial-action objective of reducing contaminant levels below cleanup objectives as presented in Section 3 would be met by this alternative and long-term management for Site 3 would not be required.

Overall Protection of Human Health and the Environment. This alternative is effective in preventing exposure of human population to contaminants in soil and sediment. Contaminant sources to groundwater would be removed.

Implementability

Technical Feasibility. All site activities planned under this alternative are technically feasible.

Administrative Feasibility. This alternative would not require long-term institutional management.

Availability of Services and Materials. Construction materials and contracting services are regionally available. Contractors and equipment required for incineration may be limited to a few permitted contractors.

Cost. The cost of Alternative S(3) is the highest of all alternatives considered. The total present-worth cost for this alternative is $1,327,567.

Reduction of Toxicity, Mobility, or Volume. Alternative S(3) would result in the reduction of toxicity, mobility, or volume of contaminants.

Compliance with ARARs. Alternative S(3) meets the MPCA leaching based cleanup goals. Action-specific ARARs would include all required construction permits, air quality permits, and MPCA incineration approval.

State Acceptance. State acceptance will be determined after review of this FS by MPCA.

Community Acceptance. Community acceptance will be determined after a review of this alternative by the community.

5.4.3 Alternative S(4): Aboveground Bioremediation

Alternative S(4) consists of securing the site with a perimeter fence, excavating contaminated soils, treating soils by biotreating, and restoring the site by regrading and revegetating. An assessment of Alternative S(4) follows:

Short-term Effectiveness. The perimeter fence in this alternative would be effective in reducing the likelihood of exposure to trespassers during the construction interim.

Long-term Effectiveness. This alternative is effective over the long term in preventing human exposure to contaminants in area sediment and soil. The remedial-action objective of reducing contaminant levels below cleanup objectives as presented in Section 3 would be met by this alternative and long-term management for Site 3 would not be required.

Overall Protection of Human Health and the Environment. This alternative is effective in preventing exposure of human population to contaminants in soil and sediment. Contaminant sources to groundwater would be removed.

Implementability

Technical Feasibility. All site activities planned under this alternative are technically feasible.

Administrative Feasibility. This alternative would not require long-term institutional management.

Availability of Services and Materials. Construction materials and contracting services are regionally available.

Cost. The cost of Alternative S(4) is moderate relative to all alternatives considered. The total present-worth cost for this alternative is $637,476.

Reduction of Toxicity, Mobility, or Volume. Alternative S(4) would result in the reduction of toxicity, mobility, or volume of contaminants.

Compliance with ARARs. Alternative S(4) meets the MPCA leaching based cleanup goals. Action-specific ARARs would include all required construction permits.

State Acceptance. State acceptance will be determined after review of this FS by MPCA.

Community Acceptance. Community acceptance will be determined after a review of this alternative by the community.

5.5 SITE 4 GROUNDWATER

All alternatives for Site 4 groundwater are presented below. The results of the analysis of these alternatives are summarized in Table 5-4.

5.5.1 Alternative GW(1): No Action

The no-action alternative for Site 4 groundwater consists of groundwater monitoring and site reviews. No other work to reduce exposure to groundwater contaminants or protect the environment from further degradation would be taken. An assessment of Alternative GW(1) follows:

Short-term Effectiveness. The likelihood of human exposure to site groundwater is low. Construction activities at the Airport such as water well drilling are controlled. It is unlikely that conditions will lead to exposure pathways in the short term.

Long-term Effectiveness. This alternative is ineffective over the long term. No remedial action objectives as presented in Section 3 would be met by the no-action alternative. Groundwater monitoring would provide the information necessary to enact appropriate corrective actions in the future.

Overall Protection of Human Health and the Environment. Similar to short- and long-term effectiveness, this alternative provides negligible protection.

TABLE 5-4

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES FOR SITE 4 GROUNDWATER
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

Criteria	Alternative GW(1): No Action
Effectiveness	
Short-term:	Likelihood of exposure is low.
Long-term: Does the alternative meet the definition of a permanent remedy?	No. No RAOs or cleanup objectives will be met by this alternative. However, natural attenuation will likely reduce contaminants below cleanup goals.
How does the treatment employed address principal threats?	No treatment is employed. Natural attenuation reduces the possibility of human exposure to groundwater contaminants. Contaminant migration to environmental receptors would be reduced over time.
To what extent are the effects of treatment irreversible?	No treatment applied.
Overall Protection of Human Health and the Environment	
What is the magnitude of the health and ecological risks associated with the residuals that will remain?	Low. There are no known exposure pathways.
Implementability	
Technical Feasibility:	Monitoring and reviews are feasible.
How reliably does the technology meet RAOs and cleanup levels?	Unknown. The rate of natural attenuation is not known at this time.
Administrative Feasibility: What type/degree of long-term management is required?	Long-term institutional management is required due to contaminants left in place and administration of the monitoring program.
Availability of Services and Materials:	
Is the technology generally available and sufficiently demonstrated?	Yes.

TABLE 5-4

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES FOR SITE 4 GROUNDWATER
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM
(Continued)

Criteria	Alternative GW(1): No Action
Reduction of Toxicity, Mobility, or Volume	
What percent of the contaminated material is destroyed/contained?	Unknown. The rate of natural attenuation is not known at this time.
What residuals remain?	VOCs, TPH, and chlorinated compounds.
What are the uncertainties associated w/land disposal	None.
Compliance with ARARs[b]	
Chemical Specific:	Benzene is above cleanup goals.
Location Specific:	None.
Action Specific:	None.
State and Community Acceptance	To be reviewed.
Cost[a]	$133,438

a Present worth cost is calculated based on a 8% discount rate over a specified term (see Section 4)

b Applicable or relevant and appropriate requirement

Implementability

Technical Feasibility. The groundwater monitoring and site reviews required for this alternative are easily implementable.

Administrative Feasibility. Considerable long-term institutional management would be associated with this alternative because contaminated groundwater would remain on site. Indefinite management of the groundwater monitoring program would be required.

Availability of Services and Materials. No construction materials or services would be required to implement this alternative.

Cost. The no-action alternative cost is the least of all alternatives considered. The total present-worth cost for this alternative is $133,438.

Reduction of Toxicity, Mobility, or Volume. The no-action alternative would not result in the reduction of toxicity, mobility, or volume of contaminants.

Compliance with ARARs. The no-action alternative will not meet the State HRLs. No location- or action-specific ARARs have been identified for this alternative.

State Acceptance. State acceptance will be determined after review of FS by MPCA.

Community Acceptance. Community acceptance will be determined after a review of this alternative by the community.

5.6 SITE 4 SOILS

All alternatives for Site 4 soil are presented in this section. The results of the analysis of these alternatives are summarized in Table 5-5. Due to the need for aviation activities to continue during the remediation efforts at Site 4, the aboveground fuel storage tanks will be operated at half the

TABLE 5-5

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES FOR SITE 4
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM

	Alternative		
Criteria	**S(1): Institutional Controls**	**S(3): Incineration**	**S(4): Aboveground Bioremediation**
Effectiveness			
Short-term:	Perimeter fence is effective in reducing contact.	Existing perimeter fence would likely be sufficient as a construction barrier. Excavation would occur over a short period of time.	Existing perimeter fence would likely be sufficient as a construction barrier. Excavation would occur over a short period of time.
Long-term: Does the alternative meet the definition of a permanent remedy?	No. Fencing alone is insufficient in eliminating health risks or preventing continued degradation.	Yes. Soil contaminants in excavated soils are destroyed.	Yes. Soil contaminants in excavated soils are destructed.
How does the treatment employed address principal threats?	No treatment is employed. Limited protection is employed to reduce risk.	Soils excavated and treated will not pose a future risk through ingestion or leach contaminants to groundwater.	Soils excavated and treated will not pose a future risk through ingestion or leach contaminants to groundwater.
To what extent are the effects of treatment irreversible?	No treatment applied.	Contaminants are permanently removed.	Contaminants are permanently removed.
Overall Protection of Human Health and the Environment What is the magnitude of the health and ecological risks associated with the residuals that will remain?	High. No protection is employed to reduce risk.	Low. Contaminants will be reduced or eliminated in treated soil.	Low. Contaminants will be reduced or eliminated in treated soil.
Implementability Technical Feasibility:	No further work required.	Construction is feasible.	Construction is feasible.
How reliably does the technology meet RAOs and cleanup levels?	This alternative will unlikely meet RAOs or cleanup levels.	This alternative meets RAOs and cleanup goals.	This alternative meets RAOs and cleanup goals.
Administrative Feasibility: What type/degree of long-term management is required?	Long-term institutional management is required due to contaminants left in place.	No long-term management is required.	No long-term management is required.

TABLE 5-5

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES FOR SITE 4
MINNESOTA AIR NATIONAL GUARD 148TH FIGHTER WING
DULUTH, MINNESOTA
FEASIBILITY STUDY ADDENDUM
(Continued)

	Alternative		
Criteria	S(1): Institutional Controls	S(3): Incineration	S(4): Aboveground Bioremediation
Availability of Services and Materials:			
Is the technology generally available and sufficiently demonstrated?	Yes.	Yes.	Yes.
Reduction of Toxicity, Mobility, or Volume What percent of the contaminated material is destroyed/contained?	No reduction in TMV is expected.	All excavated soils will be treated to cleanup goals.	All excavated soils will be treated to cleanup goals.
What residuals remain?	VOCs and chlorinated compounds.	None.	None.
What are the uncertainties associated w/land disposal residuals/untreated wastes?	None.	None.	GAC units would require off-site generation.
Compliance with ARARs[b] Chemical Specific:	Will not meet cleanup objectives.	Will meet cleanup objectives.	Will meet cleanup objectives.
Location Specific:	None.	Construction permits required.	Construction permits required.
Action Specific:	Construction permits.	Permit to incinerate soils required. Spill contingency plan to be approved by MPCA. Construction permits.	Approval by MPCA. Spill contingency plan to be approved by MPCA. Construction permits.
State and Community Acceptance	To be reviewed.	To be reviewed.	To be reviewed.
Cost[a]	$30,878	$988,013	$555,692

a Present worth cost is calculated based on a 8% discount rate over a 30-year term
b Applicable or relevant and appropriate requirement

total tankage capacity. A Spill Contingency Plan must be approved by the MPCA prior to site activities, since fuel will be present in the tanks and the associated plumbing runs prior to site activities.

5.6.1 Alternative S(1): Institutional Controls

Alternative S(1) consists of constructing a perimeter fence around the site to limit access. An assessment of Alternative S(1) follows:

Short-term Effectiveness. The perimeter fence in this alternative would be effective in reducing the likelihood of exposure to trespassers.

Long-term Effectiveness. The remedial action objective of reducing exposure to area contaminants as presented in Section 3 would be met by this alternative. However, this alternative does not reduce or remove the contaminant source to groundwater and surface water and would require long-term management for the site.

Overall Protection of Human Health and the Environment. This alternative is moderately effective in preventing exposure of human population to contaminants in soil and sediment. Further degradation of groundwater would continue as contaminants leach from soil and sediment.

Implementability

<u>Technical Feasibility.</u> All site activities planned under this alternative are technically feasible.

<u>Administrative Feasibility.</u> Considerable long-term institutional management would be associated with this alternative because contaminated materials would remain on site.

<u>Availability of Services and Materials.</u> Construction materials and contracting services are available.

Cost. The cost of Alternative S(1) is low relative $30,878.

Reduction of Toxicity, Mobility, or Volume. Alternative S(1) would not result in the reduction of toxicity, mobility, or volume of contaminants.

Compliance with ARARs. Alternative S(1) will not meet the MPCA leaching based cleanup goals. Action-specific ARARs would include all required construction permits.

State Acceptance. State acceptance will be determined after review of this FS by MPCA.

Community Acceptance. Community acceptance will be determined after a review of this alternative by the community.

5.6.2 Alternative S(3): Incineration

Alternative S(3) consists of securing the site with a perimeter fence, excavating contaminated soils, treating soils by incineration, and restoring the site by grading and revegetating. An assessment of Alternative S(3) follows:

Short-term Effectiveness. The perimeter fence in this alternative would be effective in reducing the likelihood of exposure to trespassers during the construction interim.

Long-term Effectiveness. This alternative is effective over the long term in preventing human exposure to contaminants in area sediment and soil. The remedial-action objective of reducing contaminant levels below cleanup objectives as presented in Section 3 would be met by this alternative and long-term management for Site 4 would not be required.

Overall Protection of Human Health and the Environment. This alternative is effective in preventing exposure of human population to contaminants in soil and sediment. Contaminant sources to groundwater would be removed.

Implementability

Technical Feasibility. All site activities planned under this alternative are technically feasible.

Administrative Feasibility. This alternative would not require long-term institutional management.

Availability of Services and Materials. Construction materials and contracting services are regionally available.

Cost. The cost of Alternative S(3) is the highest of all alternatives considered. The total present-worth cost for this alternative is $998,013. If this work were to occur along with incineration of soil at Site 3, the cost for this alternative would be much less.

Reduction of Toxicity, Mobility, or Volume. Alternative S(3) would result in the reduction of toxicity, mobility, or volume of contaminants.

Compliance with ARARs. Alternative S(3) meets the MPCA leaching based cleanup goals. Action-specific ARARs would include all required construction permits and MPCA thermal treatment approval.

State Acceptance. State acceptance will be determined after review of this FS by MPCA.

Community Acceptance. Community acceptance will be determined after a review of this alternative by the community.

5.6.3 Alternative S(4): Aboveground Bioremediation

Alternative S(4) consists of securing the site with a perimeter fence, excavating contaminated soils, treating soils by biotreating, and restoring the site by regrading and revegetating. An assessment of Alternative S(4) follows:

Short-term Effectiveness. The perimeter fence in this alternative would be effective in reducing the likelihood of exposure to trespassers during the construction interim.

Long-term Effectiveness. This alternative is effective over the long term in preventing human exposure to contaminants in area sediment and soil. The remedial-action objective of reducing contaminant levels below cleanup objectives as presented in Section 3 would be met by this alternative and long-term management for Site 4 would not be required.

Overall Protection of Human Health and the Environment. This alternative is effective in preventing exposure of human population to contaminants in soil and sediment. Contaminant sources to groundwater would be removed.

Implementability

Technical Feasibility. All site activities planned under this alternative are technically feasible.

Administrative Feasibility. This alternative would not require long-term institutional management.

Availability of Services and Materials. Construction materials and contracting services are regionally available.

Cost. The cost of Alternative S(4) is the moderate relative to all alternatives considered. The total present-worth cost for this alternative is $555,692. If this work were to occur along with aboveground bioremediation work at Site 3, the overall cost for this alternative would be much less.

Reduction of Toxicity, Mobility, or Volume. Alternative S(4) would result in the reduction of toxicity, mobility, or volume of contaminants.

Compliance with ARARs. Alternative S(4) meets the MPCA leaching based cleanup goals. Action-specific ARARs would include all required construction permits.

State Acceptance. State acceptance will be determined after review of this FS by MPCA.

Community Acceptance. Community acceptance will be determined after a review of this alternative by the community.

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SECTION 6.0
PREFERRED ALTERNATIVES

This section presents the preferred remedial alternatives for soil and groundwater at Sites 2, 3, and 4.

6.1 SITE 2

The preferred alternative for Site 2 groundwater is groundwater monitoring. Recent groundwater sampling has indicated that the chlorinated compounds previously detected in site groundwater have been reduced to concentrations less than MCLs or HRLs. The groundwater monitoring plan would include collecting groundwater samples from the existing monitoring well network on a quarterly basis for a period of two years. This additional data is needed to confirm conditions at the site prior to site closure.

6.2 SITE 3

The preferred alternative for Site 3 groundwater is Alternative GW(2) - French Drain. Alternative GW(2) is a viable alternative for protecting human health and the environment. In addition, this alternative would meet the RAOs. Although Alternative GW(3) would also meet RAOs, and be protective of human health and the environment, the MERD technology is considered experimental. Very little performance data exists from systems currently installed. Therefore, the overall performance of the MERD is uncertain. Finally, the MERD is approximately $1 million more expensive than the proposed french drain alternative.

The preferred alternative for Site 3 soils is Alternative S(4) - Aboveground Bioremediation. This alternative provides protection to human health and the environment, and meets the RAOs as specified in Section 3.0. Alternative S(4) is also the most cost effective of the remediation options. Although Alternative S(3) - Incineration would also satisfy the RAOs, protect human health and the environment, there are no vendors currently licensed in the State of Minnesota to incinerate soil impacted by chlorinated compounds.

6.3 SITE 4

The preferred alternative for Site 4 groundwater is Alternative GW(1) - Groundwater Monitoring. Sampling conducted during the RI (ES 1990) has indicated low levels of VOCs and total petroleum hydrocarbons. The groundwater monitoring plan would include collecting groundwater samples from the existing monitoring well network on a quarterly basis for a period of two years. This additional data is needed to confirm conditions at the site. In addition, a site review will be performed to assess the site at the conclusion of the monitoring program.

The preferred alternative for Site 4 soil and sediment is Alternative S(4) - Aboveground Bioremediation. This alternative provides protection to human health, the environment, and meets the RAOs as specified in Section 3.0. Alternative S(4) is also the most cost effective of the remediation options. Although Alternative S(3) - Incineration would also satisfy the RAOs, protect human health and the environment, there are no vendors currently licensed in the State of Minnesota to incinerate soil impacted by chlorinated compounds.

On 22 September 1995 the MPCA completed a Minnesota Decision Document that establishes the agency's final decision concerning remediation of Sites 2, 3 an 4 at the Minnesota Air National Guard base at the Duluth International Airport. A copy of this Decision Document is included as Appendix D.

APPENDIX A

NO ACTION APPROVAL LETTER FOR FTA-1

Minnesota Pollution Control Agency
520 Lafayette Road, Saint Paul, Minnesota 55155-3898
Telephone (612) 296-6300

August 29, 1991

Mr. Michael C. Washeleski, Lt. Col.
Chief, Bioenvironmental Engineering
ANGSC/SGB
Andrews AFB, Maryland 20331

Dear Mr. Washeleski:

RE: No Action Approval For The Fire Training Area 1 of Site 2,
Duluth Air Force Base

Recent developments at the Duluth International Airport (DIA) which directly affect the activities at various areas of the Duluth Air Force Base have created the need to expedite review and cleanup at certain sites that are the subject of the Request for Response Action (RFRA) issued to the Air Force, to the National Guard Bureau (NGB) and to the Minnesota Air National Guard (MANG) by the Minnesota Pollution Control Agency (MPCA) Board on August 28, 1990.

In particular, the Fire Training Area (FTA) 1 and 2, which constitute Site 2 and which has been made the responsibility of NGB and MANG, are directly affected by these recent developments. The Feasibility Study (FS) which was submitted by NGB to address its sites, including Site 2, was responded to by MPCA staff on July 24, 1991. The requirement to redraft the FS concerns specifically the need to develop alternatives to remediate the contaminated areas, for which the FS essentially recommended "no-action" alternatives.

In an effort to assist the proposed development activities at the DIA, MPCA staff reanalyzed the problem areas at Site 2, which is in the area of the proposed development activities. Specifically, the FTA-1 portion of Site 2 was reviewed pursuant to the requirements found in Part VII of Exhibit A to the RFRA. The review of the available data for the FTA-1 portion of Site 2 has allowed MPCA staff to approve that <u>no further action</u> needs to be taken at the FTA-1 portion of Site 2 at this time.

Abandonment and sealing of monitoring wells associated with the FTA-1 portion of Site 2 shall be done in accordance with Minnesota Department of Health (MDH) guidelines, with submittal of MDH abandonment forms, which shall also be copied to the MPCA. In no way shall this be considered as a release from obligation to take action in the vicinity of the former FTA-2 portion of Site 2, located to the north of the FTA-1. This FTA-1 portion of Site 2 may be utilized for other purposes at your discretion or that of the Duluth Airport Authority.

If future activities at Site 2 or other information not presently known reveal any environmental impacts associated with past or current activities at Site 2, the National Guard will be required to conduct further investigations and, if necessary, implement additional remedial actions.

The MPCA staff appreciates the actions you, the NGB, and the MANG have taken to date at Site 2. If you have any questions, or require any additional information, please contact Enrique Gentzsch (612) 296-7823 or Loren Hubert (612) 297-5573 of my staff.

Sincerely,

Gary Pulford (for)

James L. Warner, P.E.
Division Chief
Ground Water and Solid Waste Division

JLW:pk

cc: Ray Klosowski, Minnesota Air National Guard
Richard Cora, Minnesota Air National Guard
Joel Manns, Minnesota Air National Guard
Vernon Burke, Minnesota Air National Guard
Timothy Musick, MPCA, Region I

APPENDIX B

DATA TABLES FROM THE 1992 FEASIBILITY STUDY AND LABORATORY REPORTS FROM APRIL 1995 SAMPLING EVENT

ARC
Aspen Research Corporation
436 West County Road D, St. Paul, MN 55112-3522
Tel: 612/ 631-9234 Fax: 612/ 631-9270

April 13, 1995

Mike Gronseth
Montgomery Watson
545 Indian Mound
Wayzata, MN 55391

RE: ARC Project #: 15756
Project Title: Groundwater Sampling, Dang Site 3
Customer Project #: 4162.0142
Sampling Date: April 6-7, 1995
Sample Receipt Date: April 7, 1995

Dear Mr. Gronseth:

We have completed the requested analysis on the above referenced project. Enclosed you will find a summary of the results obtained. The samples analyzed are identified on the following pages.

Results were previously transmitted by facsimile as follows:

Volatiles	April 13, 1995
PAH	April 13, 1995
DRO	April 13, 1995

The analysis for the following parameters was performed according to Test Methods for the Evaluation of Solid Wastes, SW-846, 3rd Edition:

Parameter	Test Method
Volatiles (465 D list)	EPA Method 8260 modified
PAH	EPA Method 8270 modified

The determination of total petroleum hydrocarbons as fuel oil was accomplished with analysis according to the Wisconsin DNR Modified DRO Method. The method provides for quantitation of diesel range petroleum products by solvent extraction, concentration and analysis by HRGC/FID.

Thank you for using Aspen Research Corporation. We look forward to providing you with continued analytical service and support. As always, if you have questions, comments, or if we can be of further assistance, please do not hesitate to call.

Regards,

ASPEN RESEARCH CORPORATION

Jerry D. Olson

Jerry D. Olson

Analysis for Volatile Organic Compound List 465 Rev.D by Modified EPA Method 8260, SW-846 3rd Edition

Montgomery Watson Project ID: Groundwater Sampling DANG Site 3
Sampling Date: April 06, 1995
Aspen Research Corporation Project ID: 15756

Sample ID:	EQL	Meth Blk	GW-3A	B-3-MW27	B-3-MW29
ARC ID:	Water	00000	62481	62505	62511
Analyte	ug/L	ug/L	ug/L	ug/L	ug/L
Dichlorodifluoromethane	1.0	ND	ND	ND	ND
Chloromethane	1.0	ND	ND	ND	ND
Vinyl chloride	1.0	ND	ND	ND	ND
Bromomethane	1.0	ND	ND	ND	ND
Chloroethane	1.0	ND	ND	ND	ND
Dichlorofluoromethane	1.0	ND	ND	ND	BEQL
Trichlorofluoromethane	1.0	ND	ND	ND	ND
Ethyl ether	2.0	ND	ND	ND	ND
Trichlorotrifluoroethane	1.0	ND	ND	ND	ND
Acetone	4.0	ND	ND	ND	BEQL
1,1-Dichloroethene	1.0	ND	ND	ND	ND
Allyl chloride	4.0	ND	ND	ND	ND
Methylene chloride	1.0	ND	ND	ND	ND
Methyl tert-butyl ether	2.0	ND	ND	ND	ND
trans-1,2-Dichloroethene	1.0	ND	ND	ND	ND
1,1-Dichloroethane	1.0	ND	ND	ND	ND
Methyl ethyl ketone	4.0	ND	ND	ND	ND
2,2-Dichloropropane	1.0	ND	ND	ND	ND
cis-1,2-Dichloroethene	1.0	ND	ND	ND	BEQL
Chloroform	1.0	ND	ND	ND	ND
Bromochloromethane	1.0	ND	ND	ND	ND
Tetrahydrofuran	4.0	ND	ND	ND	ND
1,1,1-Trichloroethane	1.0	ND	ND	ND	1.2
1,1-Dichloropropene	1.0	ND	ND	ND	ND
Carbon tetrachloride	1.0	ND	ND	ND	ND
1,2-Dichloroethane	1.0	ND	ND	ND	ND
Benzene	1.0	ND	ND	ND	ND
Trichloroethene	1.0	ND	ND	ND	3.1
1,2-Dichloropropane	1.0	ND	ND	ND	ND
Bromodichloromethane	1.0	ND	ND	ND	ND
Dibromomethane	1.0	ND	ND	ND	ND
Methyl isobutyl ketone	4.0	ND	ND	ND	ND
cis-1,3-Dichloropropene	1.0	ND	ND	ND	ND
Toluene	1.0	ND	ND	ND	ND
trans-1,3-Dichloropropene	1.0	ND	ND	ND	ND
1,1,2-Trichloroethane	1.0	ND	ND	ND	ND
1,3-Dichloropropane	1.0	ND	ND	ND	ND
Tetrachloroethene	1.0	ND	ND	ND	1.6
Chlorodibromomethane	1.0	ND	ND	ND	ND
1,2-Dibromoethane	1.0	ND	ND	ND	ND
Chlorobenzene	1.0	ND	ND	ND	ND
1,1,1,2-Tetrachloroethane	1.0	ND	ND	ND	ND
Ethylbenzene	1.0	ND	ND	ND	ND
m,p-Xylene	2.0	ND	ND	ND	ND
o-Xylene	1.0	ND	ND	ND	ND

Montgomery Watson Project ID: Groundwater Sampling DANG Site 3
Sampling Date: April 06, 1995
Aspen Research Corporation Project ID: 15756

Analyte	Sample ID: / ARC ID:	EQL Water ug/L	Meth Blk 00000 ug/L	GW-3A 62481 ug/L	B-3-MW27 62505 ug/L	B-3-MW29 62511 ug/L
Styrene		1.0	ND	ND	ND	ND
Bromoform		1.0	ND	ND	ND	ND
Isopropylbenzene		1.0	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane		1.0	ND	ND	ND	ND
1,2,3-Trichloropropane		1.0	ND	ND	ND	ND
n-Propylbenzene		1.0	ND	ND	ND	ND
Bromobenzene		1.0	ND	ND	ND	ND
1,3,5-Trimethylbenzene		1.0	ND	ND	ND	ND
2-Chlorotoluene		1.0	ND	ND	ND	ND
4-Chlorotoluene		1.0	ND	ND	ND	ND
tert-Butylbenzene		1.0	ND	ND	ND	ND
1,2,4-Trimethylbenzene		1.0	ND	ND	ND	ND
sec-Butylbenzene		1.0	ND	ND	ND	ND
4-Isopropyltoluene		1.0	ND	ND	ND	ND
1,3-Dichlorobenzene		1.0	ND	ND	ND	ND
1,4-Dichlorobenzene		1.0	ND	ND	ND	ND
n-Butylbenzene		1.0	ND	ND	ND	ND
1,2-Dichlorobenzene		1.0	ND	ND	ND	ND
1,2-Dibromo-3-chloropropane		2.0	ND	ND	ND	ND
1,2,4-Trichlorobenzene		1.0	ND	ND	ND	ND
Hexachlorobutadiene		1.0	ND	ND	ND	ND
Naphthalene		1.0	ND	ND	ND	ND
1,2,3-Trichlorobenzene		1.0	ND	ND	ND	ND
	File Namar:		>82379	>82382	>82386	>82387
	Analysis Date:		950411	950411	950411	950411

Key:
EQL: Estimated Quantitation Limit.
ND: Not Detected at a concentration greater than 20% of the stated EQL.
BEQL: Detected at a concentration less than the EQL but greater than ND.

Analyst: [signature]
Date: 04/12/95.
Reviewed by: Jerry D. Olson

Analysis for Volatile Organic Compound List 465 Rev.0 by Modified EPA Method 8260, SW-846 3rd Edition

Montgomery Watson Project ID: Groundwater Sampling DANG Site 3
Sampling Date: April 06, 1995
Aspen Research Corporation Project ID: 15756

Sample ID:	EQL	B-3-MW35	B-3-MW25
ARC ID:	Water	62487	62499
Analyte	ug/L	ug/L	ug/L
Dichlorodifluoromethane	10	ND	ND
Chloromethane	10	ND	ND
Vinyl chloride	10	ND	30
Bromomethane	10	ND	ND
Chloroethane	10	ND	ND
Dichlorofluoromethane	10	ND	ND
Trichlorofluoromethane	10	ND	ND
Ethyl ether	20	ND	ND
Trichlorotrifluoroethane	10	ND	ND
Acetone	40	ND	ND
1,1-Dichloroethene	10	10	BEQL
Allyl chloride	40	ND	ND
Methylene chloride	10	ND	ND
Methyl tert-butyl ether	20	ND	ND
trans-1,2-Dichloroethene	10	ND	ND
1,1-Dichloroethane	10	39	BEQL
Methyl ethyl ketone	40	ND	ND
2,2-Dichloropropane	10	ND	ND
cis-1,2-Dichloroethene	10	ND	20
Chloroform	10	ND	ND
Bromochloromethane	10	ND	ND
Tetrahydrofuran	40	ND	ND
1,1,1-Trichloroethane	10	ND	ND
1,1-Dichloropropene	10	ND	ND
Carbon tetrachloride	10	ND	ND
1,2-Dichloroethane	10	ND	ND
Benzene	10	ND	ND
Trichloroethene	10	ND	130
1,2-Dichloropropane	10	ND	ND
Bromodichloromethane	10	ND	ND
Dibromomethane	10	ND	ND
Methyl isobutyl ketone	40	ND	ND
cis-1,3-Dichloropropene	10	ND	ND
Toluene	10	ND	ND
trans-1,3-Dichloropropene	10	ND	ND
1,1,2-Trichloroethane	10	ND	ND
1,3-Dichloropropane	10	ND	ND
Tetrachloroethene	10	ND	ND
Chlorodibromomethane	10	ND	ND
1,2-Dibromoethane	10	ND	ND
Chlorobenzene	10	ND	ND
1,1,1,2-Tetrachloroethane	10	ND	ND
Ethylbenzene	10	ND	ND
m,p-Xylene	20	ND	ND
o-Xylene	10	ND	ND

Montgomery Watson Project ID: Groundwater Sampling OANG Site 3
Sampling Date: April 06, 1995
Aspen Research Corporation Project ID: 15756

Analyte	Sample ID: ARC ID:	EQL Water ug/L	B-3-MW3S 62487 ug/L	B-3-MW2S 62499 ug/L
Styrene		10	ND	ND
Bromoform		10	ND	ND
Isopropylbenzene		10	ND	ND
1,1,2,2-Tetrachloroethane		10	ND	ND
1,2,3-Trichloropropane		10	ND	ND
n-Propylbenzene		10	ND	ND
Bromobenzene		10	ND	ND
1,3,5-Trimethylbenzene		10	ND	ND
2-Chlorotoluene		10	ND	ND
4-Chlorotoluene		10	ND	ND
tert-Butylbenzene		10	ND	ND
1,2,4-Trimethylbenzene		10	ND	ND
sec-Butylbenzene		10	ND	ND
4-Isopropyltoluene		10	ND	ND
1,3-Dichlorobenzene		10	ND	ND
1,4-Dichlorobenzene		10	ND	ND
n-Butylbenzene		10	ND	ND
1,2-Dichlorobenzene		10	ND	ND
1,2-Dibromo-3-chloropropane		20	ND	ND
1,2,4-Trichlorobenzene		10	ND	ND
Hexachlorobutadiene		10	ND	ND
Naphthalene		10	ND	ND
1,2,3-Trichlorobenzene		10	ND	ND
	File Namar:		>B2403	>B2405
	Analysis Date:		950412	950412
	Dilution Factor:		10	10

Key:
EQL: Estimated Quantitation Limit.
ND: Not Detected at a concentration greater than 20% of the stated EQL.
BEQL: Detected at a concentration less than the EQL but greater than ND.

Analyst: [signature]
Date: 04/12/95.
Reviwed by: Jerry D. Olson

Analysis for Volatile Organic Compound List 465 Rev.0 by Modified EPA Method 8260, SW-846 3rd Edition

Montgomery Watson Project ID: Groundwater Sampling DANG Site 3
Sampling Date: April 06, 1995
Aspen Research Corporation Project ID: 15756

Sample ID:	EQL	GW-3C	OW-75A	GW-30
ARC ID:	Water	62462	62475	62493
Analyte	ug/L	ug/L	ug/L	ug/L
Dichlorodifluoromethane	100	ND	ND	ND
Chloromethane	100	ND	ND	ND
Vinyl chloride	100	ND	ND	ND
Bromomethane	100	ND	ND	ND
Chloroethane	100	ND	ND	ND
Dichlorofluoromethane	100	ND	ND	ND
Trichlorofluoromethane	100	ND	ND	ND
Ethyl ether	200	ND	ND	ND
Trichlorotrifluoroethane	100	ND	ND	ND
Acetone	400	BEQL	ND	ND
1,1-Dichloroethene	100	ND	ND	BEQL
Allyl chloride	400	ND	ND	ND
Methylene chloride	100	ND	ND	ND
Methyl tert-butyl ether	200	ND	ND	ND
trans-1,2-Dichloroethene	100	ND	ND	ND
1,1-Dichloroethane	100	ND	ND	BEQL
Methyl ethyl ketone	400	ND	ND	BEQL
2,2-Dichloropropane	100	ND	ND	ND
cis-1,2-Dichloroethene	100	ND	BEQL	ND
Chloroform	100	ND	ND	ND
Bromochloromethane	100	ND	ND	ND
Tetrahydrofuran	400	ND	ND	ND
1,1,1-Trichloroethane	100	ND	BEQL	390
1,1-Dichloropropene	100	ND	ND	ND
Carbon tetrachloride	100	ND	ND	ND
1,2-Dichloroethane	100	ND	ND	ND
Benzene	100	ND	ND	ND
Trichloroethene	100	ND	ND	ND
1,2-Dichloropropane	100	ND	ND	ND
Bromodichloromethane	100	ND	ND	ND
Dibromomethane	100	ND	ND	ND
Methyl isobutyl ketone	400	ND	ND	ND
cis-1,3-Dichloropropene	100	ND	ND	ND
Toluene	100	ND	ND	ND
trans-1,3-Dichloropropene	100	ND	ND	ND
1,1,2-Trichloroethane	100	ND	ND	ND
1,3-Dichloropropane	100	ND	ND	ND
Tetrachloroethene	100	280	270	770
Chlorodibromomethane	100	ND	ND	ND
1,2-Dibromoethane	100	ND	ND	ND
Chlorobenzene	100	ND	ND	ND
1,1,1,2-Tetrachloroethane	100	ND	ND	ND
Ethylbenzene	100	ND	ND	ND
m,p-Xylene	200	ND	ND	ND
o-Xylene	100	ND	ND	ND

Montgomery Watson Project ID: Groundwater Sampling OANG Site 3
Sampling Date: April 06, 1995
Aspen Research Corporation Project ID: 15756

Analyte	EQL	GW-3C	OW-75A	GW-3D
Sample ID:	EQL	GW-3C	OW-75A	GW-3D
ARC ID:	Water	62462	62475	62493
	ug/L	ug/L	ug/L	ug/L
Styrene	100	ND	ND	ND
Bromoform	100	ND	ND	ND
Isopropylbenzene	100	ND	ND	ND
1,1,2,2-Tetrachloroethane	100	ND	ND	ND
1,2,3-Trichloropropane	100	ND	ND	ND
n-Propylbenzene	100	ND	ND	ND
Bromobenzene	100	ND	ND	ND
1,3,5-Trimethylbenzene	100	ND	ND	ND
2-Chlorotoluene	100	ND	ND	ND
4-Chlorotoluene	100	ND	ND	ND
tert-Butylbenzene	100	ND	ND	ND
1,2,4-Trimethylbenzene	100	ND	ND	ND
sec-Butylbenzene	100	ND	ND	ND
4-Isopropyltoluene	100	ND	ND	ND
1,3-Dichlorobenzene	100	ND	ND	ND
1,4-Dichlorobenzene	100	ND	ND	ND
n-Butylbenzene	100	ND	ND	ND
1,2-Dichlorobenzene	100	ND	ND	ND
1,2-Dibromo-3-chloropropane	200	ND	ND	ND
1,2,4-Trichlorobenzene	100	ND	ND	ND
Hexachlorobutadiene	100	ND	ND	ND
Naphthalene	100	ND	ND	ND
1,2,3-Trichlorobenzene	100	ND	ND	ND
File Namar:		>B2401	>B2402	>B2404
Analysis Date:		950412	950412	950412
Dilution Factor:		100	100	100

Key:
EQL: Estimated Quantitation Limit.
ND: Not Detected at a concentration greater than 20% of the stated EQL.
BEQL: Detected at a concentration less than the EQL but greater than ND.

Analyst: [signature]
Date: 04/12/95.
Reviwed by: Jerry A. Olson

Analysis of Diesel Range Organics
By Wisconsin Method DRO

Client Project ID: PN# 4162.0142
ARC Project ID: 15756
Date sampled: 4/6/95
Date extracted: 4/10/95
Date analyzed: 4/12/95

Sample ID:	ARC#	TPH (mg/L)	File Spec. E00000-	PQL (mg/L)
Laboratory Blank		BPQL	71.24	0.1
GW-3C	62465	0.2	71.33	0.1
GW-3C Duplicate	62467	0.2	71.32	0.1
DW-75A	62479	0.3	72.31	0.1
GW-3A	62485	BPQL	71.30	0.1
DANGB-3-MW35	62491	1.3	71.29	0.1
GW-3D	62497	0.5	71.28	0.1
DANGB-3-MW25	62503	BPQL	71.27	0.1
DANGB-3-MW27	62509	BPQL	71.26	0.1
DANGB-3-M29	62515	BPQL	71.25	0.1

Spike recovery 87%

PQL = Practical Quantitation Limit
BPQL = Not detected at a level above the practical quantitation limit

Analyst Linda Fower

Reviewed by Jerry A. Olson

GC/MS Analysis for Semivolatile Organic Compounds
by Modified Method 8270 SW-846 3rd Edition

James M. Montgomery Consulting Project ID: Groundwater Sampling DAN6 Site 3
Sampling Date: April 6, 1995 Extraction Date: April 11, 1995
Report Date: April 13, 1995 Aspen Project ID: 15756

Sample ID:	EQL	GW-3C	DW-75A	GW-3A	DAN6B3 MW35	GW-3D	DAN6B3 MW25	DAN6B3 MW27	DAN6B3 MW29
ARC ID:	Water	62466	62480	62486	62492	62498	62504	62510	62516
Analyte	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Naphthalene	10	ND	ND	ND	ND	BEQL	ND	ND	ND
Acenaphthylene	10	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	10	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	10	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	10	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	10	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	10	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	10	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	10	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	10	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	10	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	10	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	10	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	10	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	10	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(ghi)Perylene	10	ND	ND	ND	ND	ND	ND	ND	ND
File Name:		XW3169	XW3172	XW3173	XW3174	XW3175	XW3176	XW3177	XW3178
Analysis Date:		950411	950411	950411	950412	950412	950412	950412	950412

Key:
ND = Not Detected Above a Quantitation of 20% EQL
EQL = Estimated Quantitation Limit
BEQL = Detected but at a Quantitation Below the Estimated Quantitation Limit

The Method Blank File XW3168 is ND for Each of the Above Compounds

Analyzed By Steve Porto Date 4-13-95

Reviewed By Jerry D. Olson Date 4-13-95

Analysis for Volatile Organic Compound List 465 Rev.0 by Modified EPA Method 8260, SW-846 3rd Edition

Montgomery Watson Project ID: Groundwater Sampling OANG Site 3
Sampling Date: April 06, 1995
Aspen Research Corporation Project ID: 15756

Sample ID:	EQL	Meth Blk	POL-SS-1	POL-SS-2	POL-SS-3	POL-SS-4	POL-SS-6
ARC ID:	Water	00000	62517	62523	62529	62535	62547
Analyte	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
Dichlorodifluoromethane	140	ND	ND	ND	ND	ND	ND
Chloromethane	140	ND	ND	ND	ND	ND	ND
Vinyl chloride	140	ND	ND	ND	ND	ND	BEQL
Bromomethane	140	ND	ND	ND	ND	ND	ND
Chloroethane	140	ND	ND	ND	ND	ND	ND
Dichlorofluoromethane	140	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	140	ND	ND	ND	ND	ND	ND
Ethyl ether	270	ND	ND	ND	ND	ND	ND
Trichlorotrifluoroethane	140	ND	ND	ND	ND	ND	ND
Acetone	540	BEQL	BEQL	BEQL	ND	BEQL	660
1,1-Dichloroethene	140	ND	ND	ND	ND	ND	ND
Allyl chloride	540	ND	ND	ND	ND	ND	ND
Methylene chloride	140	ND	ND	ND	ND	ND	ND
Methyl tert-butyl ether	270	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	140	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	140	ND	ND	ND	ND	ND	ND
Methyl ethyl ketone	540	BEQL	ND	BEQL	BEQL	ND	ND
2,2-Dichloropropane	140	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	140	ND	ND	ND	ND	ND	ND
Chloroform	140	ND	ND	ND	ND	ND	ND
Bromochloromethane	140	ND	ND	ND	ND	ND	ND
Tetrahydrofuran	540	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	140	ND	ND	ND	ND	ND	ND
1,1-Dichloropropene	140	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	140	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	140	ND	ND	ND	ND	ND	ND
Benzene	140	ND	ND	ND	ND	ND	ND
Trichloroethene	140	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	140	ND	ND	ND	ND	ND	ND
Bromodichloromethane	140	ND	ND	ND	ND	ND	ND
Dibromomethane	140	ND	ND	ND	ND	ND	ND
Methyl isobutyl ketone	540	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	140	ND	ND	ND	ND	ND	ND
Toluene	140	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	140	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	140	ND	ND	ND	ND	ND	ND
1,3-Dichloropropane	140	ND	ND	ND	ND	ND	ND
Tetrachloroethene	140	ND	ND	ND	ND	ND	ND
Chlorodibromomethane	140	ND	ND	ND	ND	ND	ND
1,2-Dibromoethane	140	ND	ND	ND	ND	ND	ND
Chlorobenzene	140	ND	ND	ND	ND	ND	ND
1,1,1,2-Tetrachloroethane	140	ND	ND	ND	ND	ND	ND
Ethylbenzene	140	ND	ND	ND	ND	ND	BEQL
m,p-Xylene	270	ND	ND	ND	ND	ND	BEQL
o-Xylene	140	ND	ND	ND	ND	ND	ND

Montgomery Watson , Project ID: Groundwater Sampling OANG Site 3
Sampling Date: April 06, 1995
Aspen Research Corporation Project ID: 15756

Analyte	Sample ID: EQL	Meth Blk	POL-SS-1	POL-SS-2	POL-SS-3	POL-SS-4	POL-SS-6
ARC ID:	Water	00000	62517	62523	62529	62535	62547
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
Styrene	140	ND	ND	ND	ND	ND	ND
Bromoform	140	ND	ND	ND	ND	ND	ND
Isopropylbenzene	140	ND	ND	ND	ND	ND	BEQL
1,1,2,2-Tetrachloroethane	140	ND	ND	ND	ND	ND	ND
1,2,3-Trichloropropane	140	ND	ND	ND	ND	ND	ND
n-Propylbenzene	140	ND	ND	ND	ND	ND	BEQL
Bromobenzene	140	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene	140	ND	ND	ND	ND	ND	2,000
2-Chlorotoluene	140	ND	ND	ND	ND	ND	BEQL
4-Chlorotoluene	140	ND	ND	ND	ND	ND	BEQL
tert-Butylbenzene	140	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	140	ND	ND	ND	ND	ND	BEQL
sec-Butylbenzene	140	ND	ND	ND	ND	ND	ND
4-Isopropyltoluene	140	ND	ND	ND	ND	ND	580
1,3-Dichlorobenzene	140	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	140	ND	ND	ND	ND	ND	ND
n-Butylbenzene	140	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	140	ND	ND	ND	ND	ND	ND
1,2-Dibromo-3-chloropropane	270	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	140	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	140	ND	ND	ND	ND	ND	ND
Naphthalene	140	ND	ND	ND	ND	ND	180
1,2,3-Trichlorobenzene	140	ND	ND	ND	ND	ND	ND
File Names:		>B2391	>B2392	>B2393	>B2394	>B2395	>B2410
Analysis Date:		950411	950411	950412	950412	950412	950412

Key:
EQL: Estimated Quantitation Limit.
ND: Not Detected at a concentration greater than 20% of the stated EQL.
BEQL: Detected at a concentration less than the EQL but greater than ND.

Analyst: [signature]
Date: 04/13/95 Jerry A. Olson
Reviewed by:

Analysis for Volatile Organic Compound List 465 Rev.D by Modified EPA Method 8260, SW-846 3rd Edition

Montgomery Watson Project ID: Groundwater Sampling DANG Site 3
Sampling Date: April 06, 1995
Aspen Research Corporation Project ID: 15756

Sample ID:	EQL	POL-SS-5
ARC ID:	Water	62541
Analyte	ug/Kg	ug/Kg
Dichlorodifluoromethane	1400	ND
Chloromethane	1400	ND
Vinyl chloride	1400	ND
Bromomethane	1400	ND
Chloroethane	1400	ND
Dichlorofluoromethane	1400	ND
Trichlorofluoromethane	1400	ND
Ethyl ether	2700	ND
Trichlorotrifluoroethane	1400	ND
Acetone	5400	BEQL
1,1-Dichloroethene	1400	ND
Allyl chloride	5400	ND
Methylene chloride	1400	ND
Methyl tert-butyl ether	2700	ND
trans-1,2-Dichloroethene	1400	ND
1,1-Dichloroethane	1400	ND
Methyl ethyl ketone	5400	BEQL
2,2-Dichloropropane	1400	ND
cis-1,2-Dichloroethene	1400	ND
Chloroform	1400	ND
Bromochloromethane	1400	ND
Tetrahydrofuran	5400	ND
1,1,1-Trichloroethane	1400	ND
1,1-Dichloropropene	1400	ND
Carbon tetrachloride	1400	ND
1,2-Dichloroethane	1400	ND
Benzene	1400	ND
Trichloroethene	1400	ND
1,2-Dichloropropane	1400	ND
Bromodichloromethane	1400	ND
Dibromomethane	1400	ND
Methyl isobutyl ketone	5400	ND
cis-1,3-Dichloropropene	1400	ND
Toluene	1400	ND
trans-1,3-Dichloropropene	1400	ND
1,1,2-Trichloroethane	1400	ND
1,3-Dichloropropane	1400	ND
Tetrachloroethene	1400	ND
Chlorodibromomethane	1400	ND
1,2-Dibromoethane	1400	ND
Chlorobenzene	1400	ND
1,1,1,2-Tetrachloroethane	1400	ND
Ethylbenzene	1400	ND
m,p-Xylene	2700	ND
o-Xylene	1400	ND

Montgomery Watson Project ID: Groundwater Sampling DANG Site 3
Sampling Date: April 06, 1995
Aspen Research Corporation Project ID: 15756

Sample ID:	EQL	POL-SS-5
ARC ID:	Water	62541
Analyte	ug/Kg	ug/Kg
Styrene	1400	ND
Bromoform	1400	ND
Isopropylbenzene	1400	BEQL
1,1,2,2-Tetrachloroethane	1400	ND
1,2,3-Trichloropropane	1400	ND
n-Propylbenzene	1400	1,800
Bromobenzene	1400	ND
1,3,5-Trimethylbenzene	1400	11,000
2-Chlorotoluene	1400	1,400
4-Chlorotoluene	1400	1,400
tert-Butylbenzene	1400	ND
1,2,4-Trimethylbenzene	1400	3,200
sec-Butylbenzene	1400	BEQL
4-Isopropyltoluene	1400	5,400
1,3-Dichlorobenzene	1400	ND
1,4-Dichlorobenzene	1400	ND
n-Butylbenzene	1400	ND
1,2-Dichlorobenzene	1400	ND
1,2-Dibromo-3-chloropropane	2700	ND
1,2,4-Trichlorobenzene	1400	ND
Hexachlorobutadiene	1400	ND
Naphthalene	1400	BEQL
1,2,3-Trichlorobenzene	1400	ND

File Namar: >B2411
Analysis Date: 950412

Key:
EQL: Estimated Quantitation Limit.
ND: Not Detected at a concentration greater than 20% of the stated EQL.
BEQL: Detected at a concentration less than the EQL but greater than ND.

Analyst: [signature]
Date: 04/13/95. Jerry A. Olson
Revived by:

Analysis of Diesel Range Organics
By Wisconsin Method DRO

Client Project ID: PN# 4162.0142
ARC Project ID: 15756
Date sampled: 4/7/95
Date extracted: 4/10/95
Date analyzed: 4/12/95

Sample ID:	ARC#	TPH (mg/kg)	File Spec. A00000-	PQL (mg/kg)
Laboratory Blank		BPQL	71.36	4.0
POL-SS-6	62550	510*	71.37	4.0
POL-SS-5	62544	420*	71.38	4.0
POL-SS-4	62538	BPQL	71.39	4.0
POL-SS-3	62532	6.5	71.40	4.0
POL-SS-2	62526	14	71.41	4.0
POL-SS-2 Dup	62526	14	71.42	4.0
POL-SS-1	62520	14	71.43	4.0

Spike recovery 86%

PQL = Practical Quantitation Limit
BPQL = Not detected at a level above the practical quantitation limit

* Samples contain hydrocarbon product which elutes before the retention time range provided by the DRO standard.

Analyst Linda Bowen

Reviewed by Jerry D. Olson

ARC
Aspen Research Corporation

ARC PROJECT #
15756

CHAIN OF CUSTODY RECORD

6642

436 West County Road D
New Brighton, MN 55112-3522

Phone (612) 631-9234
FAX (612) 631-9270

COMPANY: Montgomery Watson	PROJECT TITLE: ~~Dang~~ Groundwater Sampling DANG Site 3
ADDRESS: Indian Mound	PROJECT NUMBER: 4162.0142
CITY, STATE, ZIP: Wayzata, MN 55391	CONTACT: Mike Grouseth PHONE: ( ) 473-4224

	SAMPLE	SAMPLE DESCRIPTION	WATER	SOIL	GRAB	COMP	PRES	DATE / TIME COLLECTED	BY	# OF BOTTLES	ANALYSIS (SEE BELOW)	
1.	GW-3C	Env. Sample	X					4-6-95 12:30	RAP MSA	6	4650 PAH DRO	
2.	GW-3C	ARC QA/QC	X					"	"	8	PAH/DRO	
3.	DW-25A	Env. Sample	X					"	"	6	465 D PAH/DRO	
4.	GW-3A	Env. Sample	X					4-6-95 14:30	"	6	4650 PAH/DRO	
5.	DANGB-3-MW35	ENV SAMPLE	X					4-6-95 1515	"	6	"	
6.	GW-3D	ENV. SAMPLE	X					4-6-95 1630	"	"	"	
7.	DANGB-3-MW25	Env Sample	X					4-6-95 1740	"	"	"	
8.	DANGB-3-MW27	Env. Sample	X					4-6-95 1820	"	"	"	
9.	DANGB-3-MW29	Env. Sample	X					4-6-95 1915	"	"	"	
10.												

SPECIAL COMMENTS	BY
NEED 4 DAY TURNAROUND	RAP
Temperature Blank = 6.4°C	

PRESERVATIVE	
FILTERED:	F
CHILLED:	C
ACID:	A
BASE:	B
NONE:	N

1.		[signature] / Montgomery Watson	[signature] / ARC	4-7-95	4:50 pm	
2.						
3.						
4.						
5.						

BTX, TPH
BTEX, TPH
EPA 8270 / 625
EPA 3820
EPA 8010 / 601
EPA 8020 / 602
EPA 8040 / 604
EPA 8060 / 606
EPA 8080 / 608
EPA 8100 / 610
EPA 8120 / 612
EPA 8140 / 614
EPA 8150 / 615
EPA 8240 / 624
EPA 1310
EPA 3020
OTHER: PLEASE SUMMARIZE ABOVE

ARC
Aspen Research Corporation

-36 West County Road D
-ew Brighton, MN 55112-3522

Phone (612) 631-9234
FAX (612) 631-9270

ARC PROJECT #
-5756

CHAIN OF CUSTODY RECORD

№ 5544

COMPANY: Montgomery Watson	PROJECT TITLE: SOIL SAMPLING DANG POL
ADDRESS: 545 INDIAN MOUND	PROJECT NUMBER: 4162.0142
CITY, STATE, ZIP: WAYZATA, MN ~~55447~~ 55391	CONTACT: MIKE GRONSETH PHONE: ( ) 473-4224

		SAMPLE	TYPE / PRESERVATIVE (SEE BELOW) WATER	SOIL	GRAB	COMP	PRES	DATE / TIME COLLECTED	BY	# OF BOTTLES	ANALYSIS (SEE ...)	
1.	POL-SS-1	Env. Sample		X				4-7-95 1000	RAP/MJH	6	4650/8260 DRO	
2.	POL-SS-2	"		X				4-7-95 1025	"	"	"	
3.	POL-SS-3	"		X				4-7-95 1055	"	"	"	
4.	POL-SS-4	"		X				4-7-95 1120	"	"	"	
5.	POL-SS-5	"		X				4-7-95 1210	"	"	"	
6.	POL-SS-6	"		X				4-7-95 1230	"	"	"	
7.												
8.												
9.												
10.												

COMMENTS	BY
NEED 4 DAY TURNAROUND	RAP
4-7-95 The sample containers for DRO Analysis were completely	
filled with soil. I called Montgomery and told them. They stated to analyze the sample for DRO anyway. JJO	
Temperature Blank = 6.4°C	

PRESERVATIVE	
FILTERED:	F
CHILLED:	C
ACID:	A
BASE:	B
NONE:	N

1.		[signature] / Montgomery Watson	[signature] ARC	4-7-95	4:50pm	
2.						
3.						
4.						
5.						

BTX, TPH
BTEX, TPH
EPA 8270 / 625
EPA 3820
EPA 8010 / 601
EPA 8020 / 602
EPA 8040 / 604
EPA 8060 / 606
EPA 8080 / 608
EPA 8100 / 610
EPA 8120 / 612
EPA 8140 / 614
EPA 8150 / 615
EPA 8240 / 624
EPA 1310
EPA 3020
OTHER: PLEASE SUMMARIZE ABOVE

ARC
Aspen Research Corporation

?36 West County Road D
New Brighton, MN 55112-3522

Phone (612) 631-?2?4
FAX (612) 631-?27?

RC PROJECT #
_5753

CHAIN OF COUNTRY RECORD

3641

COMPANY: Montgomery Watson	PROJECT TITLE: Groundwater Sampling Dang Site 3
ADDRESS: 545 Indian Mound	PROJECT NUMBER: 4162.0142
CITY, STATE, ZIP: Wayzata, MN 55391	CONTACT: ~~Mark Allen~~ Mike Granisetti PHONE: ( ) 473-4224

	SAMPLE [redacted]	SAMPLE [redacted]	TYPE / PRESERVATIVE (SEE BELOW) WATER	SOIL	GRAB	COMP	PRES	DATE / TIME COLLECTED	BY	# OF BOTTLES	ANALYSIS [redacted]	[redacted]
1.		Trip Blank						3/31/98	T.J.	1	NONE	
2.		Boiled Millipo						↓	↓	2	"	
3.		Temp Blank						↓	↓	3	"	
4.												
5.												
6.												
7.												
8.												
9.												
10.												

[redacted] COMMENTS	BY

PRESERVATIVE	
FILTERED:	F
CHILLED:	C
ACID:	A
BASE:	B
NONE:	N

[redacted]		ACCEPTED BY NAME / COMPANY [redacted]	[redacted]	TIME [redacted]	MODE OF TRANSPORTATION
1.	1-3	Tom O'Connor/Access		3/31/98		Courier
2.		[signature]/Montgomery Watson	Joy D. Olen/ARC	4-7-98	4:50	
3.						
4.						
5.						

[redacted]

BTX, TPH
BTEX, TPH
EPA 8270 / 625
EPA 3820
EPA 8010 / 601
EPA 8020 / 602
EPA 8040 / 604
EPA 8060 / 606
EPA 8080 / 608
EPA 8100 / 610
EPA 8120 / 612
EPA 8140 / 614
EPA 8150 / 615
EPA 8240 / 624
EPA 1310
EPA 3020
OTHER: PLEASE SUMMARIZE ABOVE

TABLE 3.1

SUMMARY OF SOIL CONTAMINANTS BY SITE

(Results in micrograms per kilogram unless otherwise noted.)

Analyte	Background Level	Maximum Concentration Detected			
		Site 2	Site 3	Site 4	Site 8
Volatile Organic Compounds					
Benzene	ND	3,100	900	6,200	NA
Chlorobenzene	ND	80	NA	NA	NA
1,2-Dichlorobenzene	ND	340	NA	NA	NA
1,1-Dichloroethane	ND	NA	22	NA	NA
1,2-Dichloroethane	ND	1.8	NA	NA	NA
1,1-Dichloroethene	ND	NA	37	NA	NA
trans-1,2-Dichloroethene	ND	90	14	NA	NA
Ethylbenzene	ND	25,000	260	12,000	NA
Tetrachloroethene	ND	2,300	300	NA	NA
Toluene (1)	ND	36,000	740	25,000	1,400
1,1,1-Trichloroethane	ND	NA	210	NA	NA
Trichloroethene	ND	1,600	940	NA	NA
Xylenes	ND	180,000	2,000	315,000	5.6
Semi-Volatile Organic Compounds					
4,4'-DDD	ND	NA	190	NA	180
4,4'-DDE	ND	NA	61	NA	130
4,4'-DDT	ND	NA	500	NA	1,500
Dieldrin	ND	NA	NA	NA	33
bis(2-Ethylhexyl)phthalate	ND	6,500	590	NA	NA
PCB 1254	ND	NA	1,100	NA	330
Total Petroleum Hydrocarbons (mg/kg)	ND	9,600	2,700	530	1,540
Metals (mg/kg)					
Arsenic	ND	3.7	ND	NA	NA
Barium	34.9 to 103	295	121	91.7	146
Cadmium	6.8 to 13.6	13.3	19.4	11.5	14.4
Chromium	14.4 to 42.2	37.9	44.6	49.3	43.4
Lead	2.9 to 9.9	260	30.3	7.3	11.4
Mercury	ND	NA	0.28	NA	NA

TABLE 3.1 (Continued)

Source: ES, 1990.

Abbreviations and symbols:

ES	Engineering-Science, Inc.;
mg/kg	milligrams per kilogram;
NA	his analyte was not analyzed for at this site;
ND	this analyte was analyzed for in background samples but was not detected; and
PCB	polychlorinated biphenyl.

1. The toluene levels reported for the soil samples are for the most part caused by the black tape used to seal the sample bottles (ES, 1990).

TABLE 3.2

SUMMARY OF GROUND-WATER CONTAMINANTS BY SITE

(Results in micrograms per liter unless otherwise noted.)

Analyte	Maximum Contaminant Level (MCL)	State Recommended Allowable Limit (RAL)	Maximum Concentration Detected			
			Site 2	Site 3	Site 4	Site 8
Volatile Organic Compounds						
Benzene	5.0	10.0	1.2	1.1	22	ND
1,1-Dichloroethane	NE	70.0	NA	250	NA	ND
1,2-Dichloroethane	5.0	4,000	0.22	4.4	NA	ND
1,1-Dichloroethene	7.0	6.0	0.61	58	NA	ND
trans-1,2-Dichloroethene	NE	100	1,200	450	5.8	ND
Tetrachloroethene	NE	7.0	NA	1,000	NA	ND
Toluene	NE	1,000	NA	36	NA	ND
1,1,1-Trichloroethane	200	600	NA	3,100	ND	ND
Trichloroethene	5.0	30.0	33	790	ND	ND
Vinyl Chloride	2.0	0.1	3.1	9.1	NA	ND
Xylenes	NE	10,000	NA	NA	2.7	ND
Semi-Volatile Organic Compounds						
Diethyl phthalate	NE	6,000,000	144	16	NA	ND
Dimethyl phthalate	NE	7,000,000	63	18	NA	ND
Naphthalene	NE	30,000	NA	22	NA	ND
PCB 1242	NE	0.08	NA	45	NA	ND
Total Petroleum Hydrocarbons (mg/L)			ND	ND	3.24	ND
Metals						
Barium	1,000	200	ND	1,000	170	220
Cadmium	10	4.0	ND	ND	3.1	ND
Chromium	50	100	ND	710	3.9	2.7
Lead	50	20	ND	30	ND	ND

Sources: ES, 1990; USEPA, 1989a and 1990a; and MN, 1991.

TABLE 3.2 (Continued)

Abbreviations and symbols:

ES	Engineering-Science, Inc.;
MCL	maximum contaminant level;
mg/L	milligrams per liter;
MN	Minnesota;
NA	this analyte was not analyzed for in the samples from this site;
ND	this analyte was analyzed for in the samples from this site but was not detected;
NE	not established;
PCB	polychlorinated biphenyl;
RAL	recommended allowable limit;
State	State of Minnesota; and
USEPA	U.S. Environmental Protection Agency.

TABLE 3.3

SUMMARY OF SURFACE-WATER CONTAMINANTS BY SITE

(Results in micrograms per liter unless otherwise noted)

Analyte	Maximum Contaminant Level (MCL)	State Recommended Allowable Limit (RAL)	Maximum Concentration Detected			
			Site 2	Site 3	Site 4	Site 8
Volatile Organic Compounds						
Benzene	5.0	10.0	ND	NA	930	ND
1,1-Dichloroethene	7.0	6.0	ND	35	NA	ND
trans-1,2-Dichloroethene	NE	100	2.6	82	5.3	ND
Ethyl benzene	NE	700,000	ND	NA	74	ND
Tetrachloroethene	NE	7.0	ND	10	NA	ND
Toluene	NE	1,000	ND	ND	4.3	6.5
1,1,1-Trichloroethane	200	600	ND	1,400	19	ND
Trichloroethene	5.0	30.0	ND	740	22	ND
Xylenes	NE	10,000	ND	NA	1,020	ND
Semi-Volatile Organic Compounds						
Dimethyl phthalate	NE	7,000,000	ND	12	NA	ND
Total Petroleum Hydrocarbons (mg/L)			ND	1.5	2.5	ND
Metals						
Arsenic	50	.0002	NA	20	NA	NA
Barium	1,000	200	ND	600	ND	ND
Cadmium	10	4.0	ND	14	ND	ND
Chromium	50	100	ND	200	ND	ND
Lead	50	20	ND	760	ND	40

Sources: ES, 1990; USEPA, 1989a and 1990a; and MN 1991.

Abbreviations and symbols:

ES Engineering-Science, Inc.;
MCL maximum contaminant level;

TABLE 3.3 (Continued)

mg/L	milligrams per liter;
MN	Minnesota;
NA	this analyte was not analyzed for in the samples from this site;
ND	this analyte was analyzed for in the samples from this site but was not detected;
NE	not established;
RAL	recommended allowable limit;
State	State of Minnesota; and
USEPA	U.S. Environmental Protection Agency.

TABLE 3.4

SUMMARY OF SEDIMENT CONTAMINANTS BY SITE

(Results in micrograms per kilogram unless otherwise noted.)

Parameter	Background Level	Maximum Concentration Detected			
		Site 2	Site 3	Site 4	Site 8
Volatile Organic Compounds					
Benzene	ND	ND	NA	16,000	ND
1,1-Dichloroethane	ND	ND	5.6	NA	ND
1,1-Dichloroethene	ND	ND	18	NA	ND
Ethylbenzene	ND	ND	NA	400,000	ND
Tetrachloroethene	ND	ND	5.1	NA	ND
Toluene	ND	18	NA	54,000	41,000
1,1,1-Trichloroethane	ND	ND	240	NA	ND
Trichloroethene	ND	0.26	140	ND	ND
Xylenes	ND	ND	NA	690,000	ND
Semi-Volatile Organic Compounds					
bis(2-Ethylhexyl)phthalate	ND	ND	600	NA	ND
Total Petroleum Hydrocarbons (mg/kg)	ND	ND	2000	7000	200
Metals (mg/kg)					
Arsenic	ND	NA	19	NA	NA
Barium	34.9 to 103	53.9	100	199	100
Cadmium	6.8 to 13.6	ND	7	1.3	ND
Chromium	14.4 to 42.2	20	54.6	23.4	48
Lead	2.9 to 9.9	4.8	478	23.1	190
Mercury	ND	NA	0.58	NA	NA

Source: ES, 1990.

TABLE 3.4 (Continued)

Abbreviations and symbols:

ES	Engineering-Science, Inc.;
mg/kg	milligrams per kilogram;
NA	this analyte was not analyzed for at this site;
ND	this analyte was analyzed for in background samples but was not detected; and
PCB	polychlorinated biphenyl.

APPENDIX C

MPCA LETTER DATED 14 OCTOBER 1992

Silver Celebration 25/20

Minnesota Pollution Control Agency

Celebrating our 25th anniversary and the 20th anniversary of the Clean Water Act

Ground Water & Solid Waste Division Site Response Section
Site Name
Category
Subcategory
Initials ______

October 14, 1992

Mr. Michael Washeleski, Lt. Col.
Executive Officer, Environmental Division
ANGRC/CEV, Building 3500
Andrews Air Force Base, Maryland 20331

Dear Mr. Washeleski:

RE: Draft Feasibility Study for Sites 2, 3, 4 and 8
Duluth Air Force Base

Minnesota Pollution Control Agency (MPCA) staff has reviewed the proof copy of the Feasibility Study (FS) Report for the four Minnesota Air National Guard sites at the Duluth Air Force Base in Duluth, Minnesota. This FS Report was redrafted as a result of the rejection of the previous version as documented in correspondence dated July 24 and September 17, 1991, and was prepared pursuant to the requirements of the Request For Response Action (RFRA) issued by the MPCA to the U. S. Air Force, National Guard Bureau and Minnesota Air National Guard on August 28, 1990.

Overall, the revised FS Report has generally addressed the reason for its original rejection, as well as the MPCA staff comments provided discussing technical issues. There are some additional aspects which need clarification or modification in the revised FS, which are detailed in Attachment 1 to this letter. These modifications shall be included, and the comments must be considered for inclusion, to make this FS Report approvable. Consequently, this FS Report is approved with the modifications, provided that they are included.

There are several items which are significant enough to discuss in general regarding the FS, since they constitute major factors for the overall direction of the FS, and their discussion is presented here.

1. Regarding FTA-1 of Site 2 there is significant discussion of its conditions and recommendations for a "No-Action" decision. MPCA staff fully agrees with this assessment and has in fact made such a determination in correspondence dated August 29, 1991. To assist in the redraft of the FS Report regarding this portion of Site 2, the referenced letter is enclosed herewith.

Mr. Michael Washeleski, Lt. Col.
Page Two
October 14, 1992

2. Regarding FTA-2 of Site 2, there has been some correspondence from MPCA staff regarding the future conditions of the site due to the "Line-Of-Sight" requirements stated by the Federal Aviation Agency, as detailed in the February 4, 1992, letter. Given that the final elevation at this site will be approximately 1420 feet National Geodetic Vertical Datum, according to site plans developed by Salo Engineering of Duluth, it would seem that the FS Report would be simplified in various locations if this information were to be clearly stated. Thus, to assist in the redraft of this portion of the FS Report, the referenced letter is enclosed herewith.

3. In several places of the FS Report, there is a reference to soil cleanup levels, which had not been provided for the FS but had been agreed for the "Interim Response Action" at FTA-2 of Site 2. To help the redraft of the FS in this regard, the soil cleanup levels will be provided in Attachment 2 to this letter.

4. The discussion of Site 8 identified a soil concentration of polychlorinated biphenyl (PCB) 1254 at 330 milligram/kilogram in Section 3.1.4, page 3-22, while in Table 3.1 (page 3-2) the PCB 1254 concentration is indicated as 330 microgram/kilogram. Since in the former case there will be the need to remediate the site, the original data should be reconfirmed to dispel any questions as to the actual concentrations.

5. The FS Report indicates for the various alternatives a semiannual sampling frequency. This shall be revised throughout the FS Report in light of the RFRA requirement of quarterly sampling.

More detailed modifications on specific aspects of the FS are found in the Attachments. Should you have concerns or comments on this letter or its Attachments, please contact Richard Jolley at (612) 297-5573 or Enrique Gentzsch at (612) 296-7823 of my staff.

Sincerely,

James L. Warner

James L. Warner, P.E.
Division Manager
Ground Water and Solid Waste Division

JLW:pk

Mr. Michael Washeleski, Lt. Col.
Page Three
October 14, 1992

Enclosures: Attachment 1: Modifications and Comments
Attachment 2: Soil Cleanup Levels
MPCA letter dated August 19, 1991
MPCA letter dated February 4, 1992

cc: Richard Cora, Minnesota Air National Guard, Duluth
James Stauber, Minnesota Air National Guard, Duluth
Vernon Burke, Minnesota Air National Guard, St. Paul
JoAnn Sherwin, Engineering Science, Oak Ridge
Timothy Musick, Minnesota Pollution Control Agency, Duluth
Sangsook Choi, U.S. Environmental Protection Agency, Region V

ATTACHMENT 1

Modifications and Comments to the Feasibility Study Report (Proof Copy) for the Minnesota Air National Guard Base in Duluth, Minnesota, dated June 1992

The modifications contained herein are requirements that shall be incorporated into the Feasibility Study (FS) Report for Sites 2, 3, 4 and 8 of the Duluth Air Force Base (DAFB). The comments provided in this Attachment need to be considered for an acceptable FS Report.

Part I. Modifications

1. Section 1.3, pg. 1-8, first paragraph.
   It is stated in this paragraph that "health-based cleanup levels for the contaminated ground water on Base are probably inappropriate." This type of conclusion seems inappropriate in this section on feasibility study objectives, approach and report organization. In addition, the statement is inaccurate in that Minnesota's nondegradation policy for natural waters is ultimately designed to be protective of human and ecological risks.

   Also on this page regarding the statement "levels of cleanup for soil based on potential for contaminants to leach to ground water," it is unclear what levels of cleanup are being referred to.

2. Section 1.3, pg. 1-8
   In the discussion of potential cleanup criteria, no mention was made of the soil cleanup levels set by Minnesota Pollution Control Agency (MPCA) pursuant to the "Procedures For Establishing Soil Cleanup Levels" Version 1. This document shall be cited as another cleanup criterion. The actual cleanup numbers are provided in Attachment 2.

3. Section 1.3, pg. 1-11
   The criteria indicated to be used in evaluating potential technologies referred to reduction of contaminant mobility, toxicity and volume, to the prevention of exposure, to contaminated ground water, and the restoration of contaminated ground water. This FS Report shall also discuss in this regard the other factors identified in Tasks A and B of Part VI to Exhibit A to the Request For Response Action. This modification also applies to the screening of alternatives discussed in Section 4.

4. Table 3.1, pg. 3-2
   Background levels are reported for numerous constituents as non-detected (ND). In future reports such data presented in

tables shall be noted either as their respective magnitude (i.e., < 0.5 microgram/liter (ug/l)) or the detection limits shall be included in a separate column within the summary table for comparison.

5. Table 3.2, Summary of Ground Water Contaminants By Site, pg. 3-4
For Site 2, this table indicates that Perchloroethylene (PCE), Toluene, 111-Trichloroethane (TCA) and Xylenes were not analyzed. It also indicates Xylene was not analyzed at Site 3. Information from the Remedial Investigation indicates, however, that Method 8010 and 8020 were used for these samples and Appendix L has the reported analytical results for these compounds. It appears that the "not analyzed" (NA) should actually be ND's. The table shall be modified to accurately reflect existing data.

6. Section 3.1.4.1, 3-20
The discussion of total petroleum hydrocarbons at Site 8 is too cursory. Total Petroleum Hydrocarbons (TPH) levels greater than 50 milligram/kilogram (mg/kg) occur at several locations and must be addressed. All levels of TPH greater than 50 mg/kg shall be addressed in the report as significant contamination potentially requiring remediation. If remediation for soils containing levels of TPH at or greater than 50 mg/kg is not recommended, rationale must be presented to support the "no-action" recommendation.

Also, the minimum detection limit of 100 mg/kg is too high and for future verification sampling the detection levels shall be no higher than 50 mg/kg. A minimum detection limit even lower than 50 mg/kg is preferred.

7. Section 3.3, pp. 3-39 et seq
The Baseline Risk Assessment was developed strictly for human exposure. No significant discussion occurred for the Ecological Risk, in light of the Minnesota Non-Degradation Goal stated in the 1989 Ground Water Protection Act, Minn. Stat. 103H, and developed in Minnesota Rule 7060.

8. Section 4, pp. 4-1 et seq
The FS does not provide a Table of Applicable or Relevant and Appropriate (ARARs) factors for soil, sediment surface and ground waters. The ARARs of concern for the various media that apply to the sites shall be presented in tabular form with a corresponding discussion.

9. Section 4.2.1.2, pg. 4-18
Alternative 2 consisting of a multilayered cap is considered applicable to Site 2 FTA-2 area and to Site 3. As stated in the cover letter, the "Line-Of-Sight" (LOS) requirements

established by the Federal Aviation Administration (FAA) for Site 2 cause this alternative to be inappropriate for Site 2. For Site 3, this alternative could be potentially applicable, but since treatment of contaminants is preferred, the cap would also be found to be inadequate. Therefore, this alternative shall be rejected for all sites at the DAFB.

10. Section 4.2.1.7, pg. 4-22, first paragraph
Low temperature thermal treatment (soil roasting) is described as being effective for volatile organic compounds (VOCs) but not for semi-volatile organic compounds (SVOCs). Low temperature roasters in Minnesota are currently approved only for typical nonhalogenated petroleum VOCs such as Benzene, Ethylbenzene, Toluene and Xylene (BETX) and TPH contaminated soils. Treatment of soils that contain other contaminants such as metals or halogenated VOCs is approved only on a site by site basis by the Air Quality Division of the MPCA. For soil containing low levels of SVOCs and halogenated solvents treatability studies or compliance testing may provide sufficient data on air quality to allow approval by the Air Quality Division. The report shall be modified to reflect these considerations.

Section 4.2.1.7, pg. 4-22, fourth paragraph
Alternative S7 (excavation and low temperature thermal treatment) is not applicable to Site 2 and would be only limited to treatment of soils from Site 3 that contain only nonhalogenated petroleum related VOCs, TPH or very low (trace) amounts of other solvents. See above comment.

11. Section 4.2.2.2, pg. 4-25
The text shall be modified to indicate that ground water shall be sampled at least initially on a quarterly basis.

12. Section 4.2.2.2 - 4.2.2.5
In these sections, options that utilize an interceptor trench are discussed in the development of alternative sections. Only one section (4.2.2.2) discusses discharge of water to the sanitary sewer, the other options (4.2.2.3 - 4.2.2.5) discuss the use of an interceptor trench with discharge to a nearby stream following treatment. It is assumed in this discussion that treatment of the water will not be required prior to discharging to the sanitary sewer. If this assumption is made, the rationale underlying this assumption shall be stated explicitly. If, alternatively, additional treatment prior to discharging to the sanitary sewer is possible or likely at some locations, this alternative shall be discussed.

13. Section 4.2.3.1, Alternative SW1, pg. 4-27
In the discussion of the soil washing treatment option, the contaminated water used in the treatment process is allowed to drain onto the site and back into existing contaminated ground water. It may be necessary, however, to treat this waste

process water to avoid deterioration of site soils and ground water or discharge to the sanitary sewer or surface stream. This shall be discussed within the report.

14. Section 4.3.1, pg. 4-32
The statement "no sediment contamination exists" in reference to Site 3 at the end of the first paragraph is incorrect. Please refer to cleanup levels presented in Attachment II for a discussion of relevant contaminants of concern.

15. Section 4.3.1, pg. 4-33
No mention is made of the locally high levels of TPH at Site 8 which range from 160 to 3300 mg/kg from surface soil and sediment locations. This contamination shall be addressed within the report.

In Table 4.4, no contamination is indicated for Site 8 with the note that either all analytes were below the cleanup range or below the detection limit. The enclosed cleanup levels for the individual sites will allow Engineering Science to determine if levels are above or below cleanup requirements. Levels of TPH are locally higher than the 10 to 50 parts per million range typically used for cleanup requirements on many similar tank and tank farm sites in Minnesota. After reviewing the enclosed cleanup levels any and all contamination at or above these goals shall be acknowledged. If some locations are concluded not to require remediation, supporting rationale shall be presented in all cases.

16. Table 4.3, pg. 4-16
Due to considerations for treating soil at Site 8 with TPH levels 50 mg/kg or higher, Site 8 shall be added for consideration to Alternative S3 and S7. All discussion and conclusions regarding the remediation of these soils shall include a rationale for its selection.

Also regarding Alternative S2, since a cap cannot be considered at Site 2, acknowledgment must be made of the FAA LOS requirements for Site 2. The text shall be changed to reflect the excavation required by the FAA as part of the LOS requirements.

Again the LOS requirements should be discussed in Section 4.3.2.2, pg. 4-40 with regard to the option of a cap at Site 2.

17. Section 4.3.2.3, pg. 4-42, last sentence.
Landfarming is indicated to be applicable for soil at Site 2 and sediment at Site 3 and sediment at Site 4. As indicated previously, due to the levels of halogenated VOCs at Site 2, approval for this treatment must be given by the Air Quality Division on a site specific basis. Within this discussion the specific contaminants to be considered for landfarming shall be indicated.

18. Table 4.5
Under the Ease of Implementability, the statement that treated water may need permit for discharge to Publicly Operated Treatment Works shall be corrected to read "require an NPDES permit" if discharging to surface water.

19. Table 5.1
This table indicates the TCLP criterion for benzene is 5 milligram/liter (mg/l). This should be 0.5 mg/l as indicated in the text in Sections 5.1.2 and 5.1.3. The text shall be modified with this correction.

20. Section 5.2.1, pg. 5-10, first paragraph
This section indicates that Alternative S1/W1 will be suitable for soils at Site 8. Due to the levels of TPH contaminated soils above 50 mg/kg, complete rationale for not recommending remediation for these soils shall be presented.

Also in the following paragraph the point is made that no additional capital expense would be expected for this option; this, however, is not true at Site 2 where FAA LOS requirements shall require the installation of additional monitoring points following the remediation and abandonment of the existing monitoring wells at Site 2.

21. Section 5.2.3, pg. 5.15-5.25
The landfarm option, alternative S3 may be the most cost effective and appropriate treatment for Site 2, Site 3 and Site 8 soils and sediment from Site 3 and Site 4. However, landfarming approval for soils containing trace amounts or higher concentrations of VOCs must be approved through the MPCA Air Quality Division. This may also alter the criteria for landfarming as discussed on pages 5-17 in Section 5.2.3. Sampling and analysis requirements may be modified also by the MPCA as site conditions require. Cleanup standards shall also be modified from the MPCA BETX landfarm guidance, due to the presence of VOCs, SVOCs and trace levels of pesticides and PCBs.

Soils considered likely for the landfarm option at Site 3 are indicated to be at the pad and the ditch. However, no acknowledgment is given regarding the soil contamination in other "hot spots" at locations away from the pad. Both these soils and the TPH contaminated soils shall be discussed within this section with regards to the landfarm option.

22. Section 5.2.6, pg. 5-27, first paragraph
There appears to be an apparent contradiction between the estimated time for ground water remediation as discussed in Section 5.2.5 for Site 2 and 3 compared with the shorter estimates in Section 5.2.6. The report shall be modified to clarify or address this contradiction.

Comments

1. Section 1, Introduction, pg. 1-1, Figure 1.1
Why is Site 8 the only site shown on this vicinity map? It would be more appropriate to either show no site locations or show all four sites of concern (but only after reference in the text).

2. Section 3.1.3.1, pg. 3-18
A reference is made to toluene concentration at Site 4 in this section. The specific concentration of toluene being referenced should be stated explicitly. Additionally, it may be useful to resample soil areas showing at least the highest levels of toluene, to be able to have more certainty when dismissing the findings of the remedial investigation.

3. Section 3.1.4.3, pg. 3-2
Lead contamination is reported as high as 190 mg/l. This concentration of 190 mg/l is significantly higher than the ARARs for lead and must be addressed as such.

4. Section 4.3.1, pg. 4-28
Reference for PCB guidance for cleanup is U.S. Environmental Protection Agency 1990c not 1990b.

5. Section 4.3.1, pg. 4-32
January 1991, Release 3 of the Minnesota Department of Health Recommended Allowable Levels for benzene is 0.010 ppm not 0.012 ppm as indicated.

6. Section 4.3.1, pg. 4-32
The preliminary screening of alternatives for surface water at Site 4 indicates that no-action would be dependent upon sediment remediation. However, it may also enhance surface water restoration to place an oil-absorbent boom across the channel at the culvert as it flows beneath the taxiways and runway.

7. Table 5.5, and subsequent tables; pp. 5-19 et seq
The cost estimates presented do not all add up to the totals given. These cost estimates should be reviewed and revised as appropriate.

8. Table 5.6, pg. 5-22
Depending upon the PCBs and TPHs at Site 8, the cost estimates for Site 8 should be included in the cost estimates.

9. Section 5.2.6, pg. 5-28
The discussion of optimal destruction of target compounds, such as 1,1,1-TCA is unclear and should be clarified.

10. Section 6, pp. 6-1 et seq
The recommendations for the various sites may need to be modified according to the issues raised before, i.e., LOS for

Site 2, and PCB treatment depending upon the correct units of the laboratory results. Since the Minnesota Air National Guard will be providing thermal treatment to a large quantity of BETX contaminated soil, it may be beneficial to explore the possibility of adding the sediment from Site 4 to the soil which will be thermally treated.

ATTACHMENT 2

This Attachment to the proof draft of the Feasibility Study, for Sites 2, 3, 4 and 8 of the Duluth Air Force Base, contains the soils cleanup levels required for soils that may remain at those sites and which will not require additional cleanup. These cleanup levels had been set for Fire Training Area 2 of Site 2 during the spring of 1992, on the occasion when an interim response action was contemplated. Thus, this Attachment will serve to formalize those cleanup levels for the respective parameters, which will also be applicable to Sites 3, 4 and 8.

Soil exhibiting contaminant levels greater than those stated here for the parameters indicated shall be remediated:

Chemical	Cleanup Level
Trichloroethene	600 micrograms/kilogram (ug/kg)
Tetrachloroethene	600 ug/kg
Benzene	500 ug/kg
Total BETX	5,000 ug/kg
TPH	50,000 ug/kg (or 50 milligram/kilogram (mg/kg))

Additionally, the following cleanup levels shall also apply for soils at the four referenced sites:

Chemical	Cleanup Level
PCBs	10 mg/kg
Lead	500 mg/kg

Other chemical contaminants have been identified as present in the soils or sediments of some sites. However, the concentration levels do not exceed action levels, for which reason no cleanup levels are provided herein.

Cleanup levels for ground water are set essentially by the non-degradation goal of the Ground Water Protection Act of 1989. Thus, cleanup levels are established by the Maximum Contaminant Levels (MCLs) developed by U.S. Environmental Protection Agency, or by the Recommended Allowable Limits (RALs) developed by the Minnesota Department of Health, which constitute Applicable or Relevant and Appropriate Requirements.

APPENDIX D

DECISION DOCUMENT

Minnesota Pollution Control Agency

RECEIVED

OCT 13 1995

[illegible]

September 22, 1995

Captain Steve Wabrowetz
148 FG/EMO
4680 Viper Street
Duluth, Minnesota 55811-6033

Mr. Paul Wheeler
Environmental Division
ANG/CEVR, 3500 Fetchet Avenue
Andrews AFB, Maryland 20331-5157

RE: Minnesota Decision Document, Sites 2, 3, and 4, Duluth Air Force Base

Dear Captain Wabrowetz and Mr. Wheeler:

The Minnesota Pollution Control Agency (MPCA) staff has established the agency's final decision concerning the remediation of Sites 2, 3, and 4 (the operable units) at the Duluth Air Force Base site. I have enclosed a copy of the Minnesota Decision Document for the operable units.

The MPCA staff thanks you for your continued efforts to expedite the investigation and the remediation of the operable units at the Duluth Air Force Base site. If you have any questions regarding environmental issues at the Base, please contact me at (612) 296-7710.

Sincerely,

J. Todd Goeks

J. Todd Goeks
Project Manager
Response Unit I
Site Response Section
Ground Water and Solid Waste Division

JTG:ch

Enclosure

cc: Mr. Jal Guzder, EETCO (w/enc)
Mr. Hank Storms, Duluth Airport Authority (w/enc)
Mr. Carlos Naranjo, Operational Technologies (w/enc)
Mr. Gary Wirtz, American Engineering & Testing (w/enc)
Mr. Brad Kalberg, Bay West, Inc. (w/enc)

MINNESOTA DECISION DOCUMENT

SITE DESCRIPTION

Former Duluth Air Force Base
Minnesota Air National Guard (ANG) Base, Duluth International Airport (IAP), St. Louis County, Minnesota

<u>Operable Units</u>
Site 2; Fire Training Area 2
Site 3; Defense Property Disposal Office, renamed: Defense Reutilization and Marketing Office
Site 4; Defense Fuels Tank Farm Area

STATEMENT OF PURPOSE

This Minnesota Decision Document (Document) presents the selected remedial actions for operable units Sites 2, 3, and 4 at the Duluth Air Force Base (DAFB) site, and summarizes the facts and determinations made by the Minnesota Pollution Control Agency (MPCA) Commissioner or his delegate (the Commissioner) in approving the recommended response action alternatives. The selected response actions are intended to ensure cleanup of the contaminant source to a level that: 1) will preclude future degradation of currently clean ground water at and in the vicinity of Sites 2, 3, and 4; and 2) precludes contaminant leaching to the ground water, thereby preventing potential future releases of contaminants to the unconsolidated glacial aquifer and the underlying bedrock aquifers.

The Commissioner has determined that the response actions set forth in this Document are reasonable and necessary to protect the public health and welfare and the environment from the release and threatened release of hazardous substances and/or pollutants and contaminants from Sites 2, 3, and 4 at the DAFB site.

DESCRIPTION OF PROBLEM

The DAFB site is located principally within and adjacent to the Duluth International Airport (IAP) complex. The airport is located approximately seven miles northwest of the city of Duluth.

The operable units addressed in this Document are described as follows:

Site 2

Site 2 is comprised of approximately 30 acres north of Runway 9/27 and west of Runway 3/21 and was formerly operated from the early 1960s until 1987 as a fire training area. Several drums of waste oil contaminated soil from Site 3 were spread over the fire training area in 1980. Soil was contaminated with jet propulsion fuel No. 4 and petroleum related volatile organic compounds (VOCs). Ground water was contaminated with VOCs.

Site 3

Site 3 consists of approximately five acres located southwest of the fuel farm between the east-west taxiway and Washington street. During 1965 through 1980, an area approximately 90 feet by 75 feet was used to store waste oils, waste solvents, and other waste chemicals. Soil is contaminated with VOCs, petroleum hydrocarbons, and pesticides. Ditch sediments are contaminated with VOCs and petroleum hydrocarbons. Ground water is contaminated with VOCs, metals, and polychlorinated biphenyls. Surface water is contaminated with VOCs, metals, and petroleum hydrocarbons.

Site 4

Site 4 is approximately 15 acres located northeast of Site 3, south of the east-west taxiway and north of Washington Street. The site has been operated as an aviation and diesel fuel farm since 1950. Soil, ditch sediments, ground water, and surface water are contaminated with VOCs and petroleum hydrocarbons.

DOCUMENTS REVIEWED

The Commissioner has based his decision primarily on the following documents describing the characteristics of DAFB Sites 2, 3, and 4 and the effectiveness and cost analysis of the response action alternatives for Sites 2, 3, and 4:

> MPCA Correspondence Files, 1995, 1994, 1993, 1992.
>
> Draft Final Feasibility Study Addendum, Sites 2, 3, 4, and 8, Minnesota Air National Guard Base, Duluth IAP, Duluth Minnesota, Montgomery-Watson, May 1995.
>
> Management Action Plan, 148th Fighter Group, Minnesota Air National Guard, Duluth IAP, Duluth Minnesota, Radian Corporation, September 1994.
>
> Removal Action Excavation Report, FTA-2, IRP Site 2, Duluth IAP, Twin Ports Testing Inc., December 1994.
>
> Feasibility Study Proof Copy, Sites 2, 3, 4, and 8, Minnesota Air National Guard Base, Duluth IAP, Duluth Minnesota, Engineering Science, June 1992.

Remedial Investigation Report, Sites 2, 3, 4, 8, and 10, Minnesota Air National Guard Base, Duluth IAP, Duluth Minnesota, Engineering Science, January 1990.

DESCRIPTION OF RESPONSE ACTIONS ALREADY COMPLETED

Site 2

During October 1993, an interim response action excavation was conducted at Site 2 wherein 3,500 cubic yards of petroleum contaminated soil was excavated from the site and land spread nearby on ANG property. In July 1994, an additional 6,067 cubic yards of petroleum contaminated soil was excavated, completing the interim response action excavation. This soil was stored in a covered stockpile until June 1995 when it was thermally treated off site at Earth Burners, Inc. soil treatment facility.

Site 3

Several drums of waste oil contaminated soil were removed from Site 3 and were deposited at Site 2 fire training area in 1980.

Site 4

No response actions have been conducted at Site 4.

ESTABLISHMENT OF RESPONSE ACTION OBJECTIVES AND CLEANUP LEVELS

The response action objectives have been stated above in the Statement Of Purpose. Clean-up levels were conveyed to the ANG in a letter dated October 14, 1992, and are restated below.

Compound	Soil Cleanup Level (mg/kg)
Trichlorethene	0.6
Tetrachlorethene	0.6
Benzene	0.5
Total BTEX	5
TPH	50
PCBs	10
Lead	500

The interim response action at Site 2 achieved the clean-up levels for soil.

Ground water clean-up levels were set at the lower of the Maximum Contaminant Level or the Minnesota Department of Health Recommended Allowable Limit (as superseded by Health Risk Limits).

Surface water clean-up levels, which have not been previously established, are set at the MPCA Aquatic Life Standards for Class 2 Waters. The aquatic life standards listed are the Chronic Standards for class 2B waters. The ditches at Sites 3 and 4 are classified as a class 2B surface water bodies.

Compound	Surface Water Clean-up Level (ug/l)
Trichlorethane	263
Trichlorethene	120
Tetrachlorethene	8.9
Benzene	114
Xylene	166
Oil (TPH)	200
Lead[1]	3.2
Cadmium[1]	1.1
Chromium III[1]	207
Chromium VI	11

[1] The aquatic life standards for class 2 waters for these metals are hardness dependent. Since the aquatic life standards are based on a hardness of 100 mg/l, the chronic and maximum standards for cadmium, chromium (III), and lead must be multiplied by a conversion factor for Sites 3 and 4. The conversion factor is dependent on the average hardness of the surface water in these ditches.

DESCRIPTION OF SELECTED RESPONSE ACTIONS

Several response action alternatives were evaluated for the Site. The selected response actions for the operable units are outlined below, and include ex-situ bioremediation for soils at Sites 3 and 4, ground water collection with carbon adsorption treatment at Site 3, and natural attenuation for ground water at Sites 2 and 4.

Site 2

The interim remedial measures taken at the site have achieved the response action objectives and clean-up levels for soil. The ground water contamination at the site has been attenuating naturally; several of the clean-up levels have been attained. Ground water impacts exceeding clean-up levels remain at the site; therefore, the selected alternative for the site is natural attenuation with quarterly ground water monitoring to verify the attainment of clean-up levels. Clean-up levels will be considered attained once contaminant concentrations at or below clean-up levels have been achieved for three consecutive monitoring events.

Site 3

Prior to construction, a security fence will be erected to prevent accidental public exposure to site contaminants during remediation activities. Soil and sediments contaminated above the clean-up levels will be excavated in the former waste storage area and from the drainage ditches on site. A total of approximately 4,400 cubic yards of contaminated soil and sediment will be excavated.

The excavated soil and sediment would be loaded into trucks, covered with tarps, and hauled to a location on the ANG Base for incorporation in an aboveground bioremediation cell. Excavated soil and sediment will be shredded, mixed with nutrients and bulking agents, and placed in a lined bioremediation cell. Vapor phase contamination from the treatment cell will be captured through an air manifold system and treated by activated carbon adsorption prior to discharge to the atmosphere. The excavated areas will be restored to grade with uncontaminated fill and regraded and revegetated or paved.

A french drain system, including interceptor trenches, will be installed to collect contaminated ground water and surface water at the site. Contaminated water will be pumped from the french drain system through activated carbon adsorption treatment vessels to remove contaminants prior to discharge to the publicly owned treatment works.

Ground water monitoring will be conducted quarterly for two years following the contaminant source removal and semi-annually thereafter to determine whether contaminant concentrations have decreased as expected and when clean-up levels are being attained. Clean-up levels will be considered attained once contaminant concentrations at or below clean-up levels have been achieved for three consecutive monitoring events.

Site 4

Soil comprising the containment berms of the tank farm will be removed. Soil and sediments contaminated above the clean-up levels will be excavated from within the bermed area and from the drainage ditches on site. A total of approximately 4,600 cubic yards of contaminated soil and sediment will be excavated. As the tank farm is currently an operating facility, any contaminated soils that may be present beneath the concrete tank pads will be remediated when the tank farm is closed and relocated. The current tank farm is scheduled for closure and relocation within the next five years by the Defense Fuels Supply Corps.

The excavated soil and sediment would be loaded into trucks, covered with tarps, and hauled to a location on the ANG Base for incorporation in an aboveground bioremediation cell. Excavated soil and sediment will be shredded, mixed with nutrients and bulking agents, and placed in a lined bioremediation cell. Vapor phase contamination from the treatment cell will be captured through an air manifold system and treated by activated carbon adsorption prior to discharge to the atmosphere. The excavated areas

will be restored to grade with uncontaminated fill and regraded and revegetated as appropriate. The tank containment berms will be reconstructed with uncontaminated material.

The ground water contamination at the site has been attenuating naturally. Ground water impacts exceeding clean-up levels remain at the site; therefore, the selected alternative for the site is natural attenuation with quarterly ground water monitoring to verify the attainment of clean-up levels.

STATUTORY DETERMINATIONS

The selected response actions are consistent with the Minnesota Environmental Response and Liability Act of 1983 and are not inconsistent with the Federal Comprehensive Environmental Response, Compensation, and Liability Act and the National Contingency Plan, 40 CFR. Part 300. I have determined that the selected response actions are protective of public health and welfare and the environment. The remedy has been selected in accordance with the criteria set forth in the August 28, 1990, Request for Response Action issued to the National Guard Bureau, the Minnesota Air National Guard, and the U. S. Air Force by the MPCA. Clean-up levels will be considered attained once contaminant concentrations at or below clean-up levels have been achieved for three consecutive monitoring events.

Gordon E Weyant
for James L. Warner, P.E.
Division Manager
Ground Water and Solid Waste Division

9/12/95
Date